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Calloway et al.

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(45) **Date of Patent: Aug. 2, 2022**

(54) **CABLE BROOM**

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A46B 9/06	(2006.01)
A46B 9/02	(2006.01)

(52) **U.S. Cl.**

CPC ***A46B 9/06*** (2013.01); ***A46B 9/02*** (2013.01); ***A46B 13/008*** (2013.01); *A46B 2200/3066* (2013.01)

(58) **Field of Classification Search**

CPC A46B 3/00; A46B 3/14; A46B 3/16; A46B 9/02; A46B 9/06; A46B 7/04; A46B 13/008; E01H 1/02; E01H 1/05

See application file for complete search history.

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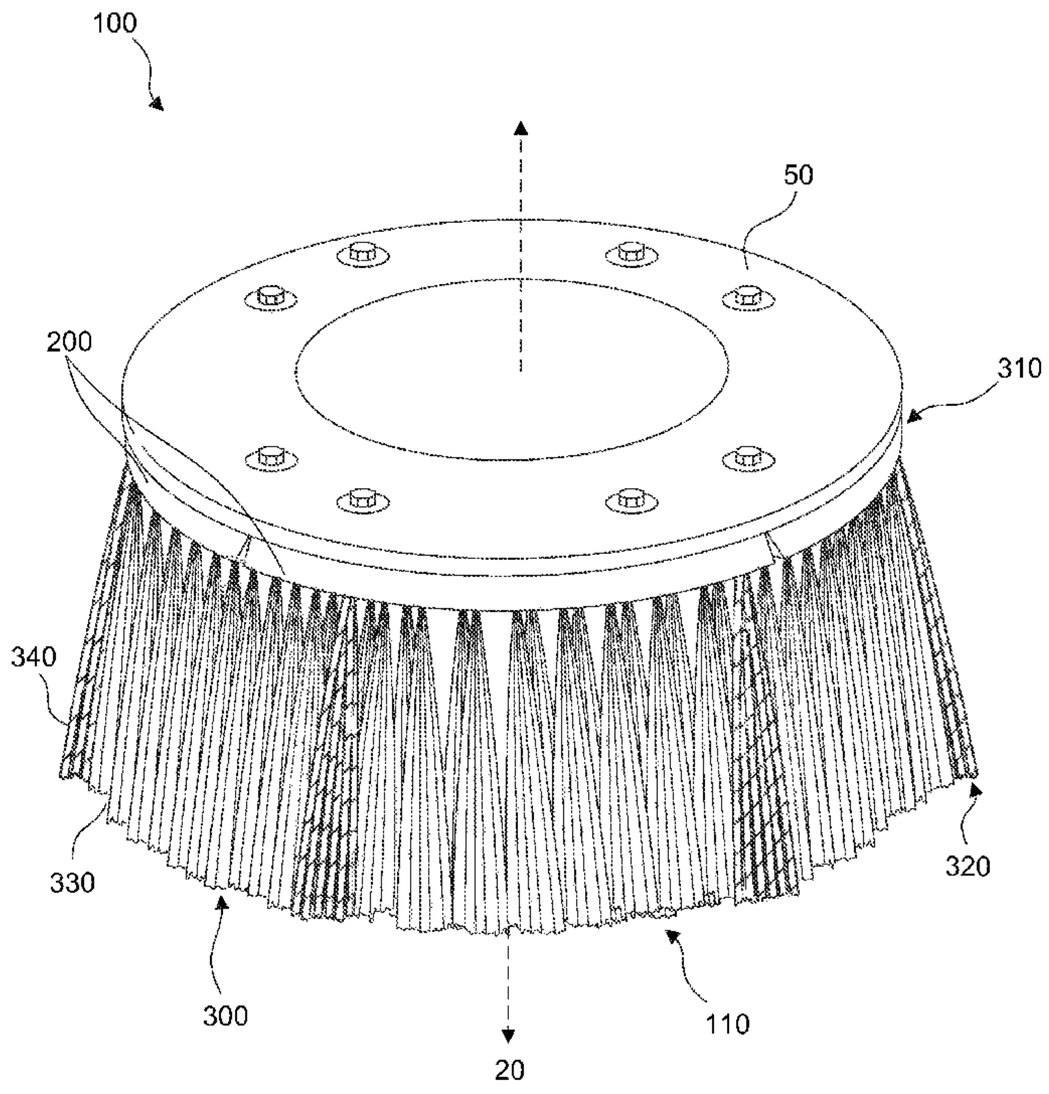
(57) **ABSTRACT**

A gutter broom is provided. The gutter broom can include one or more block segments, each block segment having openings in which bristles are positioned. The bristles can have a first stiffness or a second stiffness different than the first stiffness. Bristles having the second stiffness can be positioned radially outward of bristles having the first stiffness on a block segment.

21 Claims, 19 Drawing Sheets



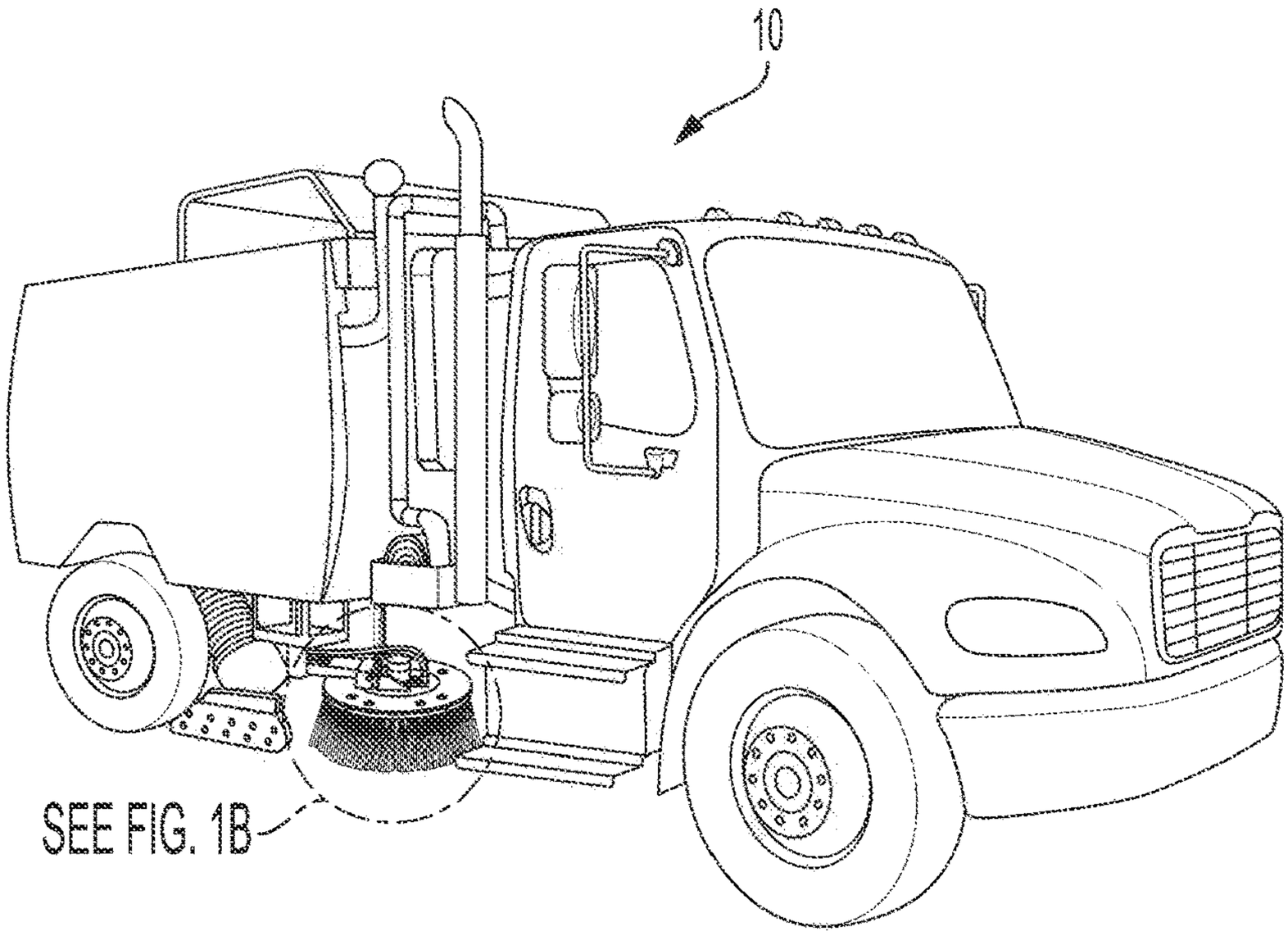


FIG. 1A

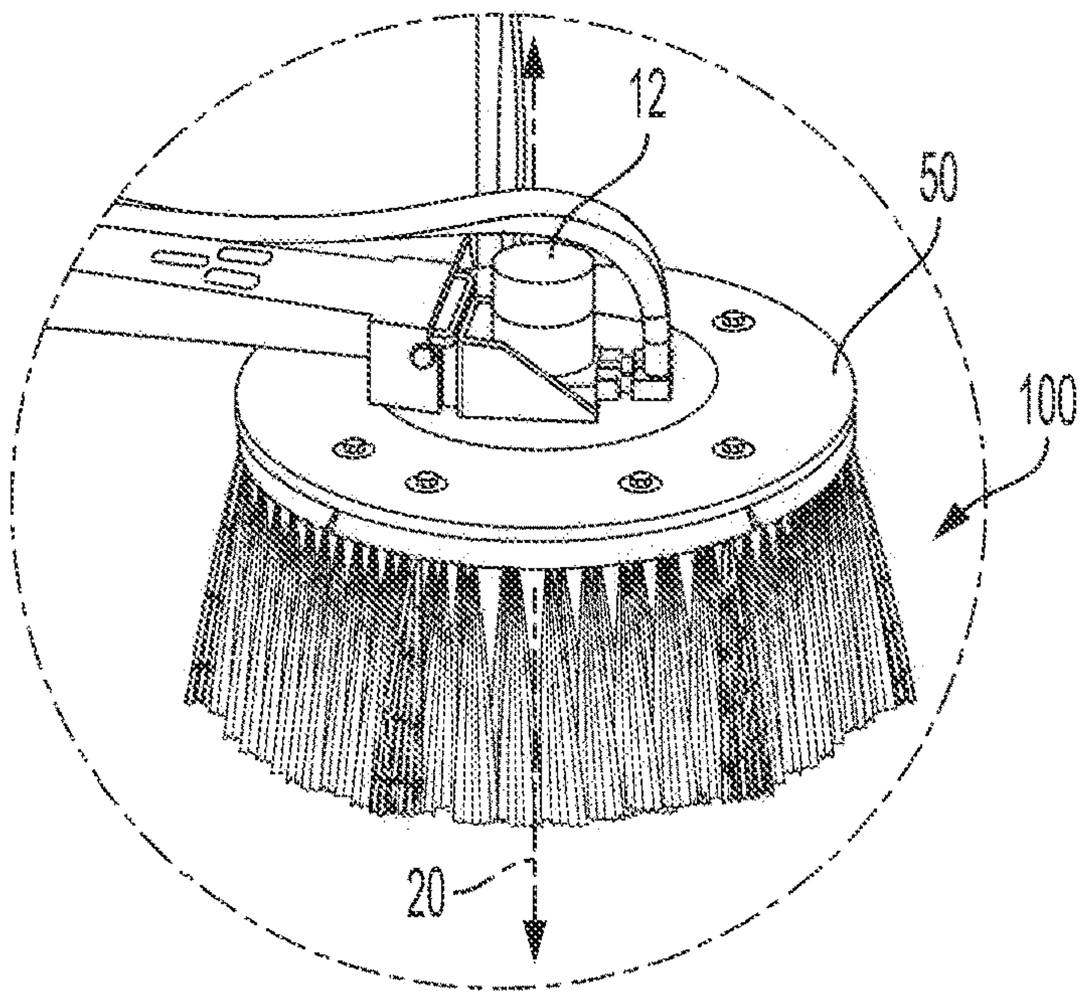


FIG. 1B

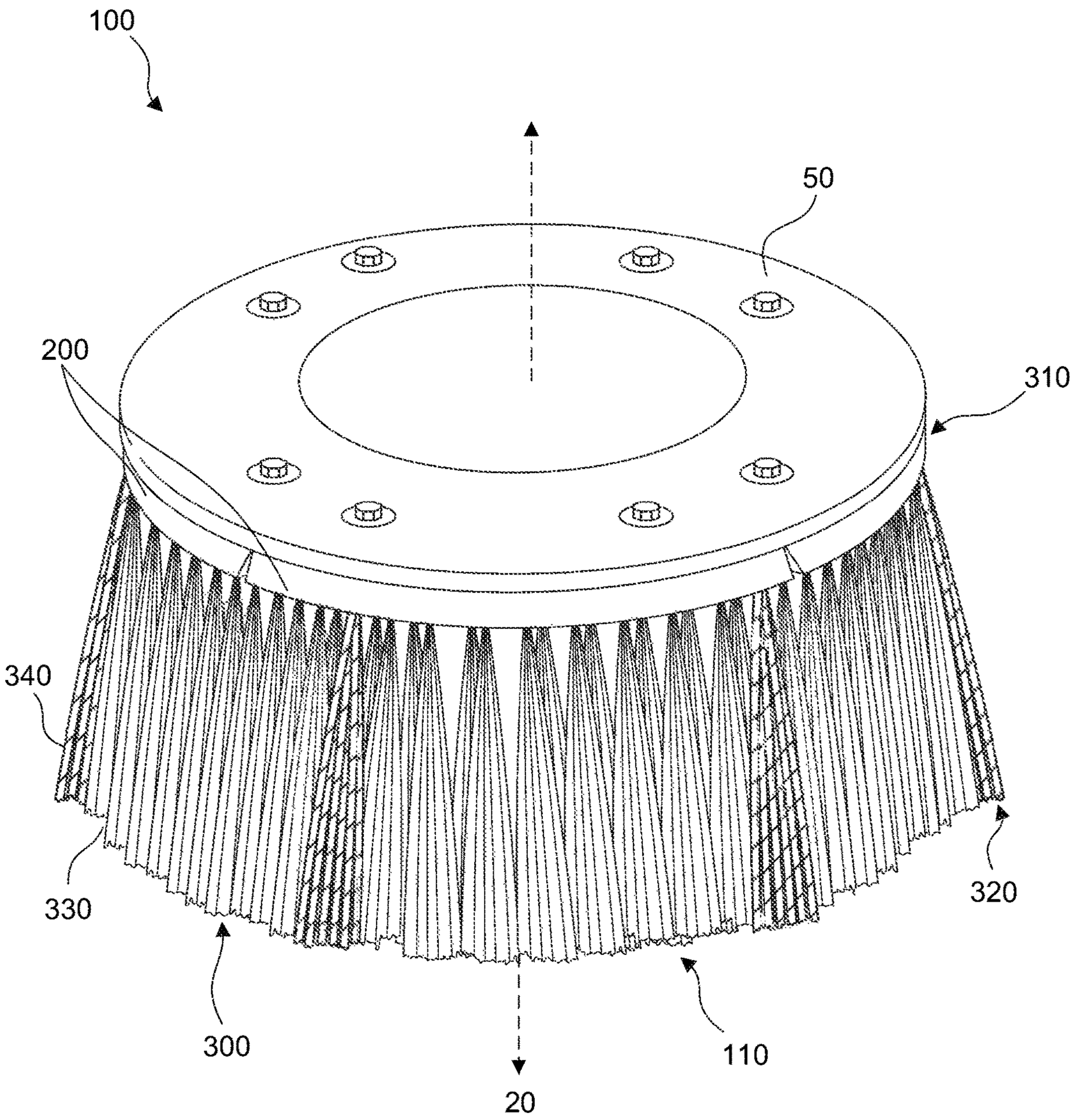


FIG. 2

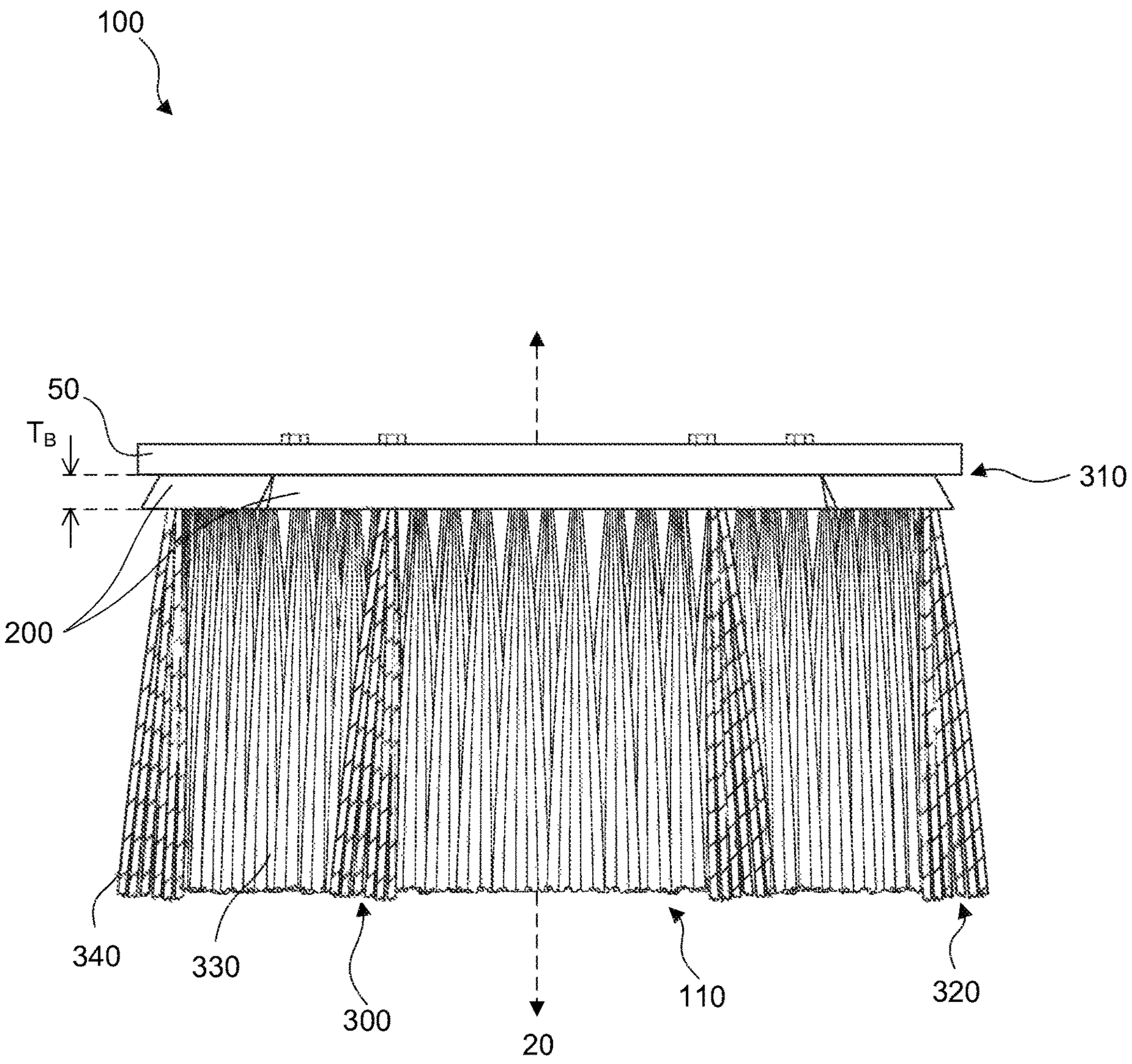


FIG. 3

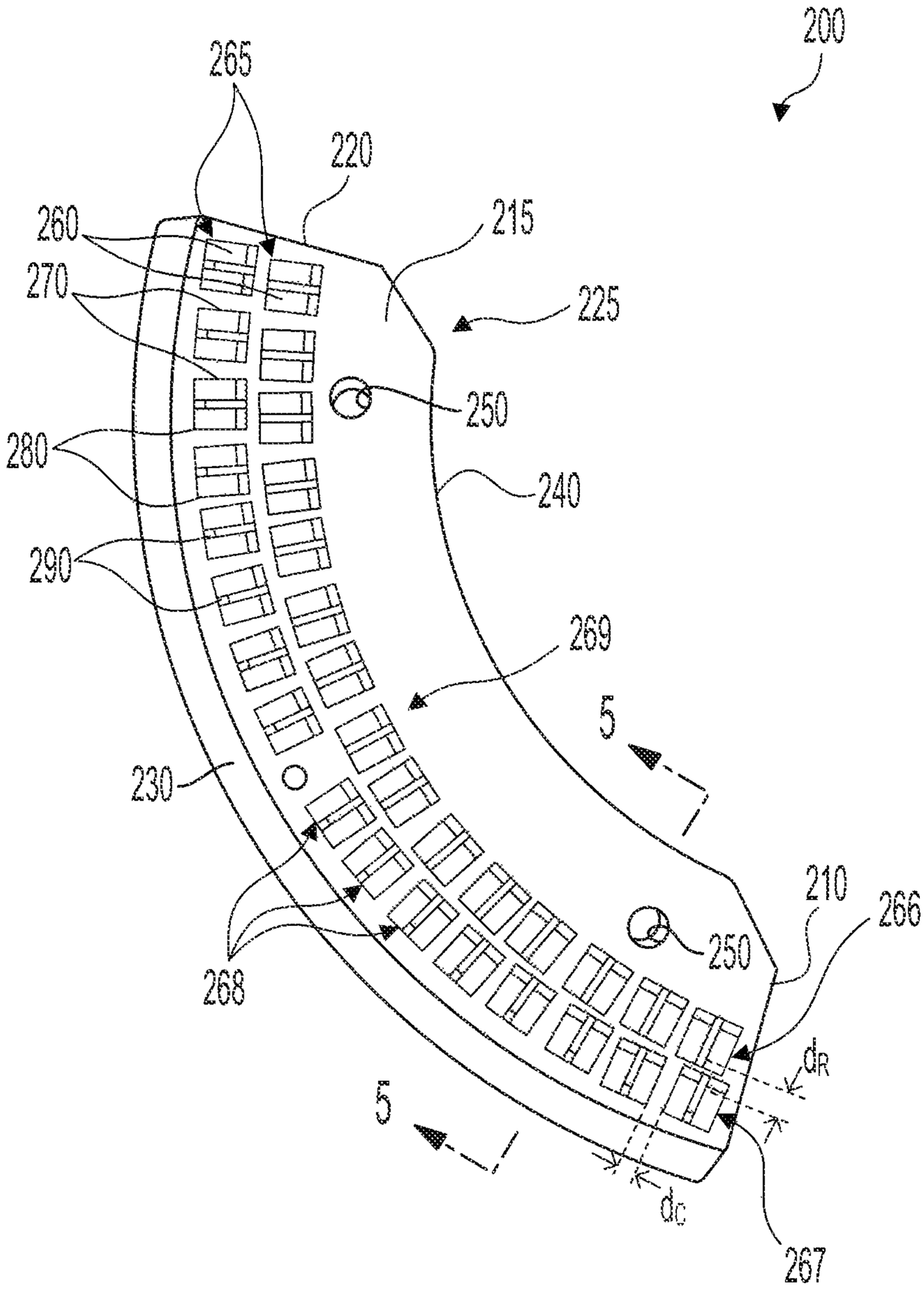
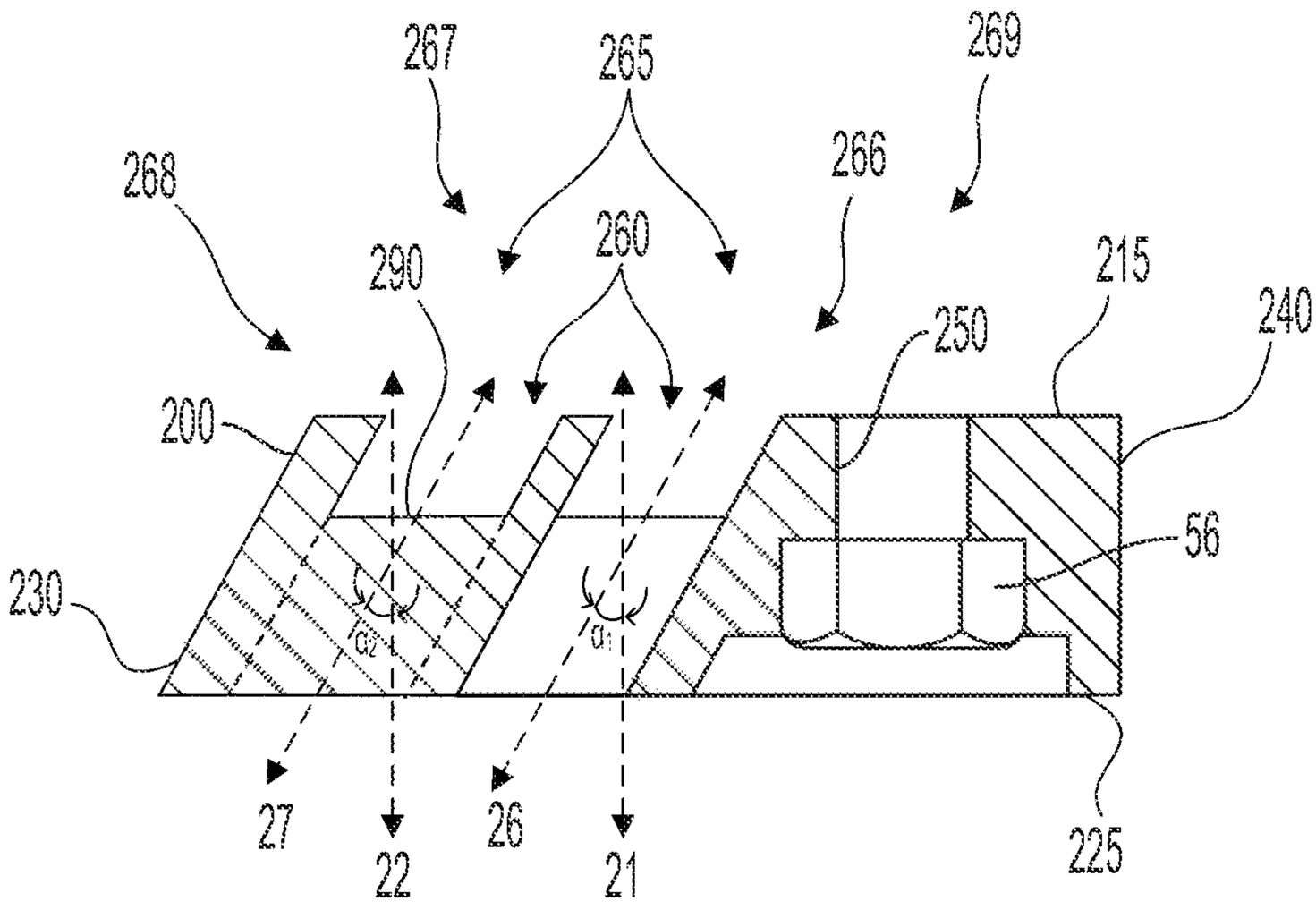

200
265
220
215
260
270
225
250
280
240
290
269
5
230
210
266
250
268
d_R
5
d_C
267

FIG. 4


267
265
269
268
266
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215
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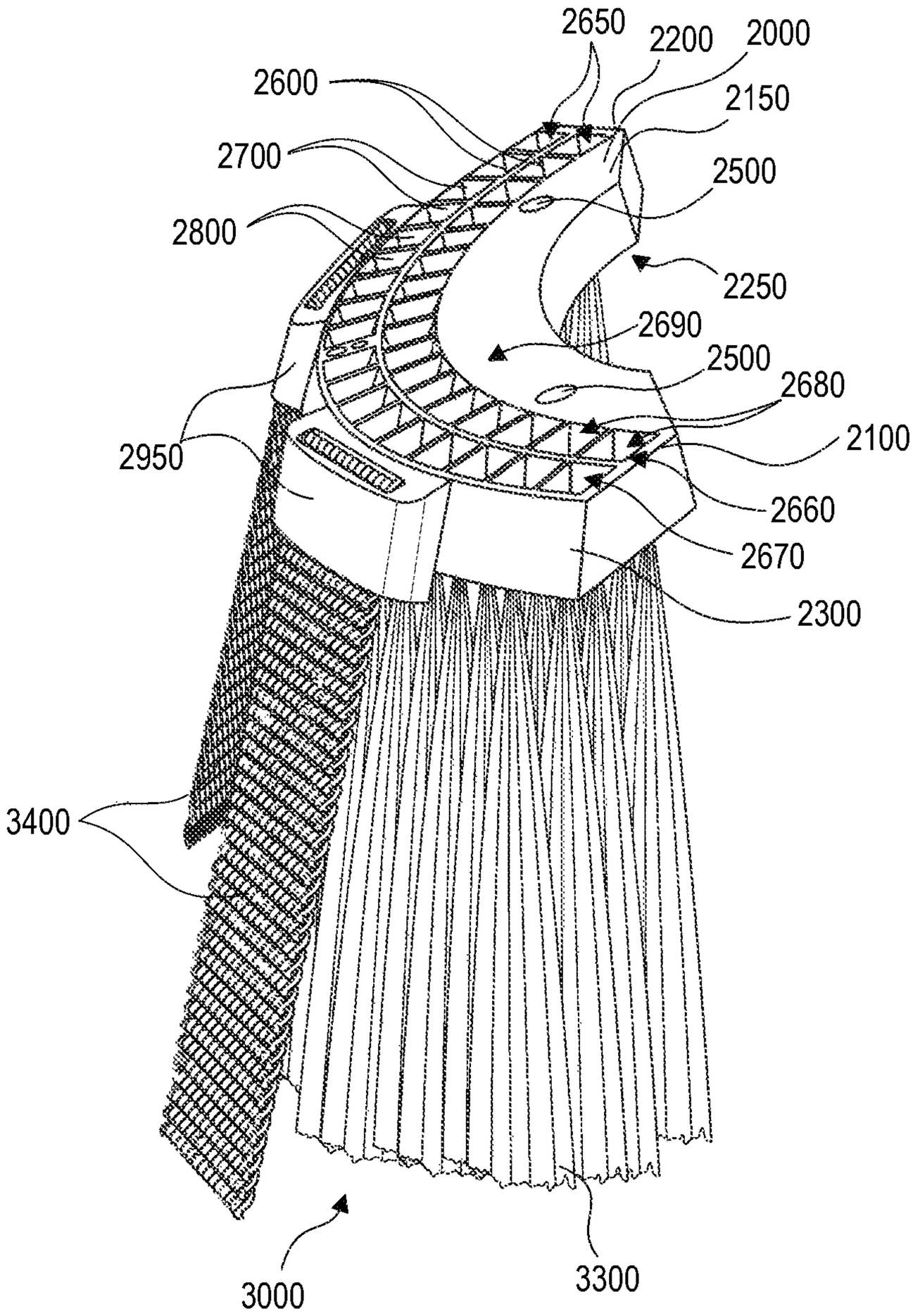
250
200
56
230
α_2
α_1
27
22
26
21
225

FIG. 5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2600
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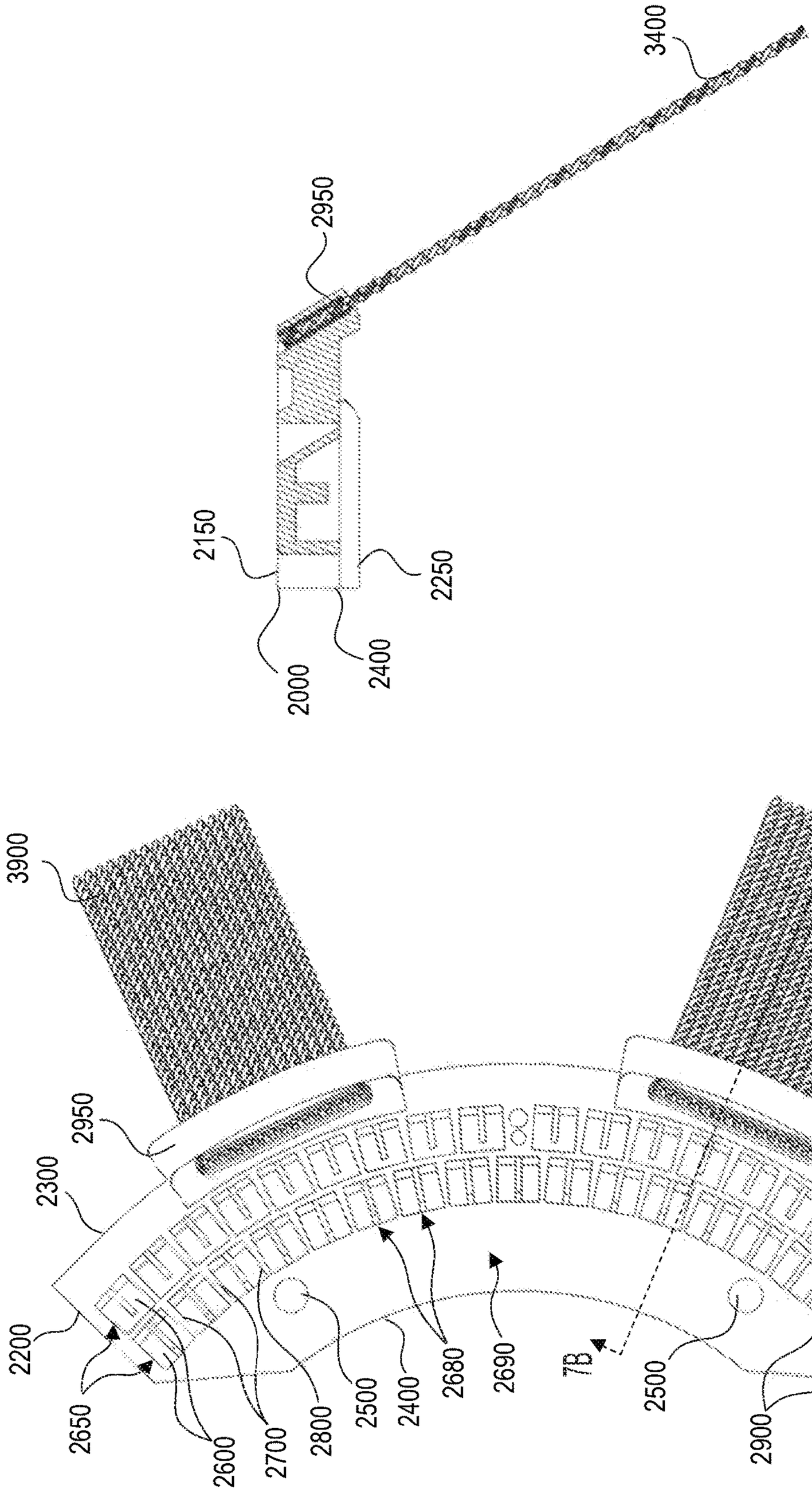
2300
3400
3300
3000

FIG. 6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2150
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2000
2400
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7B
3400
2950
2300
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2200
2150
2650
2600
2700
2800
2500
2400
2680
2690
7B
2500
2900
2670
2660
2100

FIG. 7B

FIG. 7A

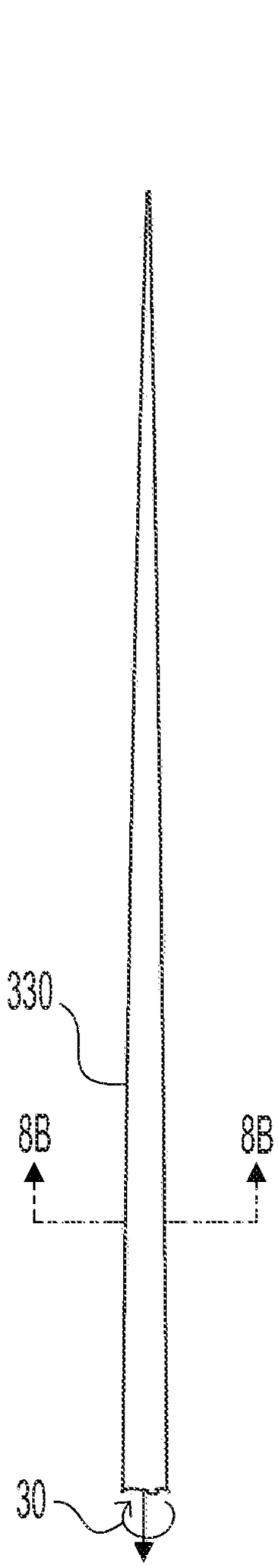

FIG. 8A

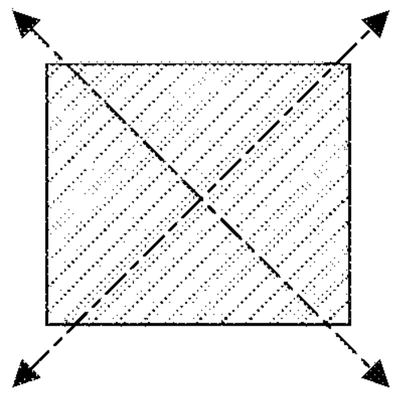

FIG. 8B

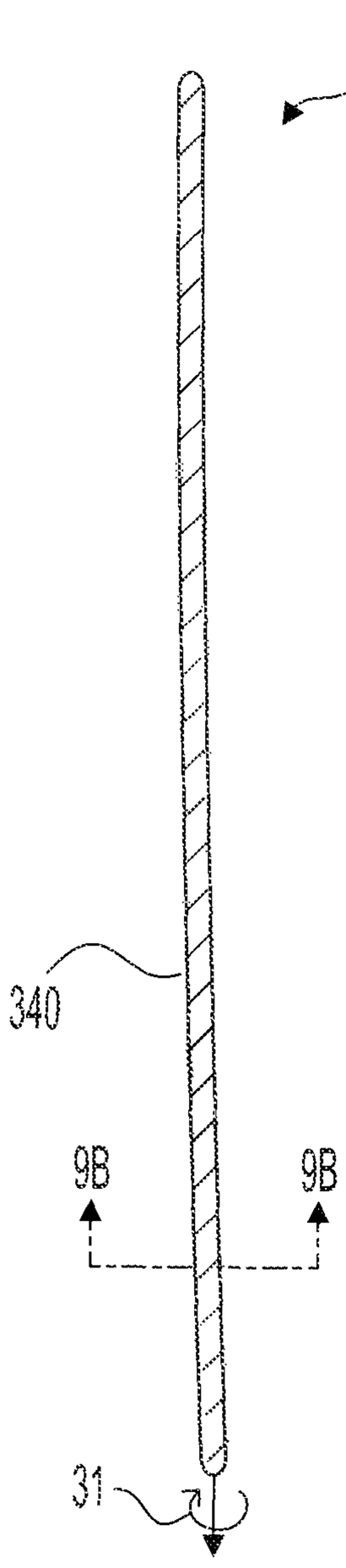

FIG. 9A

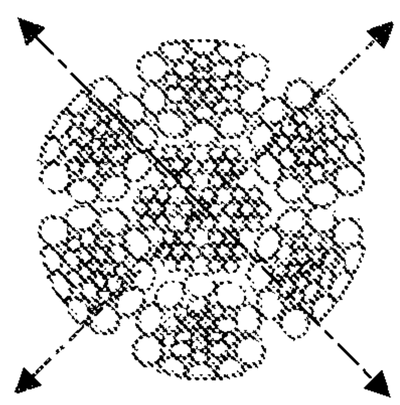

FIG. 9B

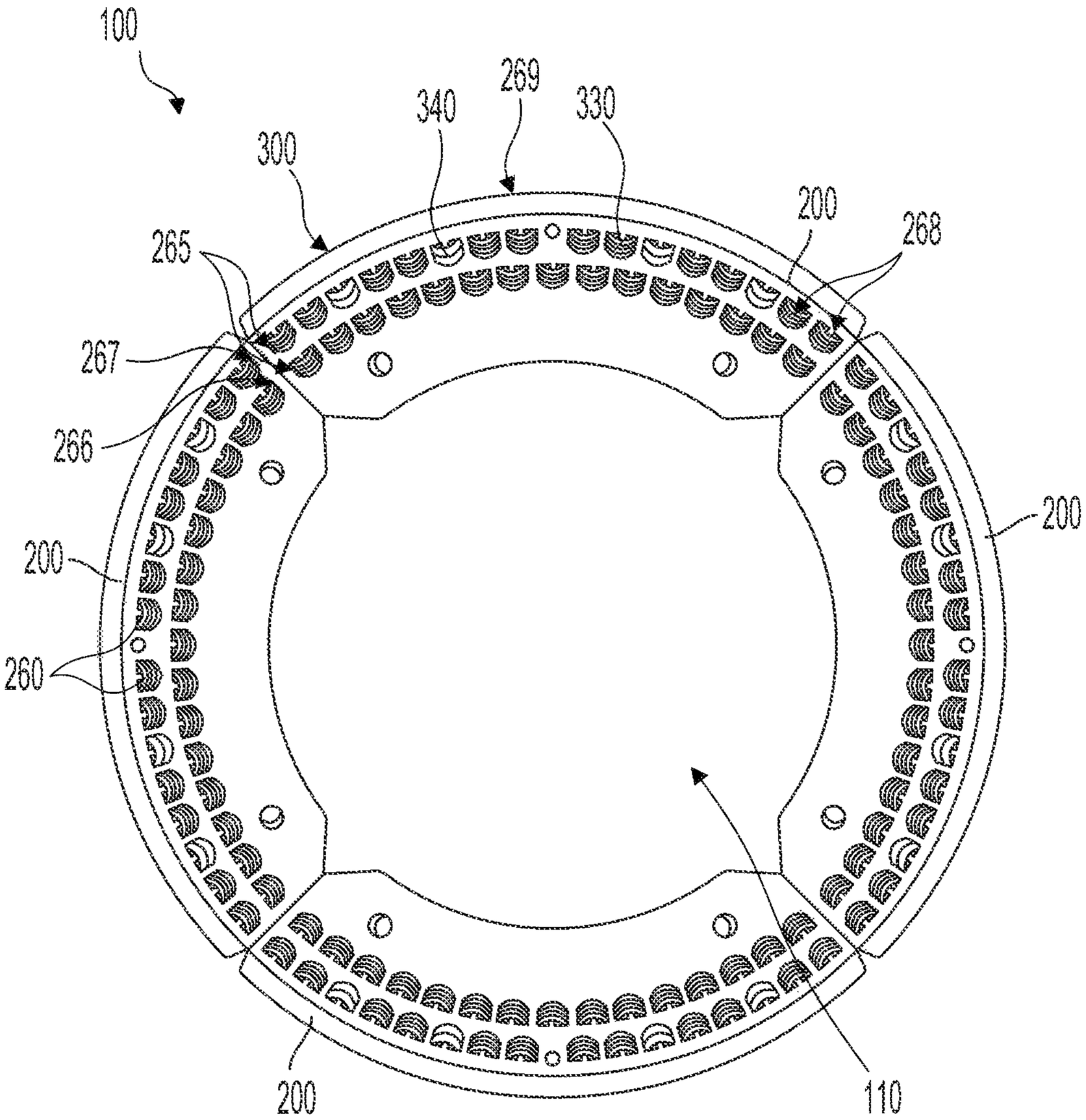

FIG. 10A

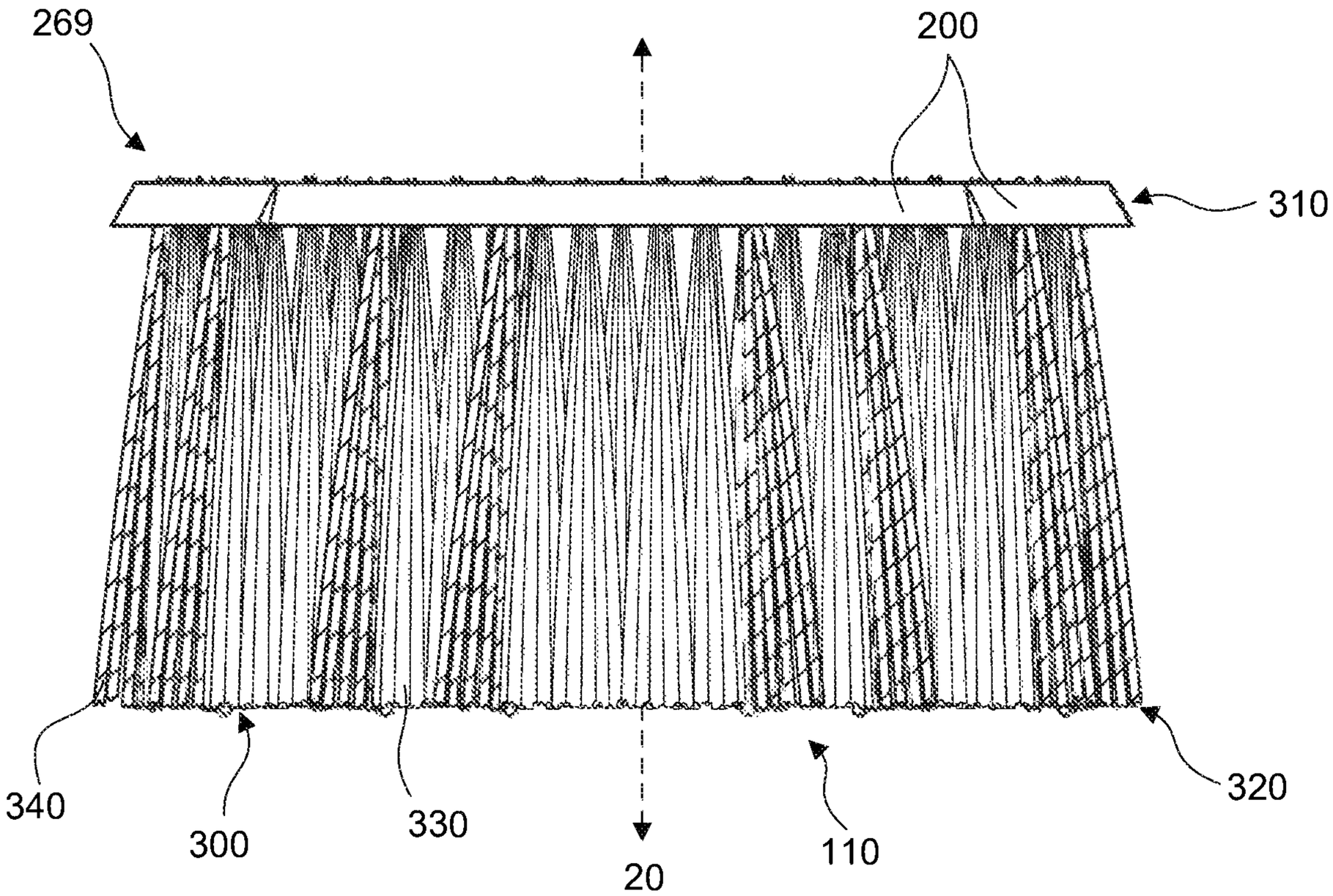

FIG. 10B

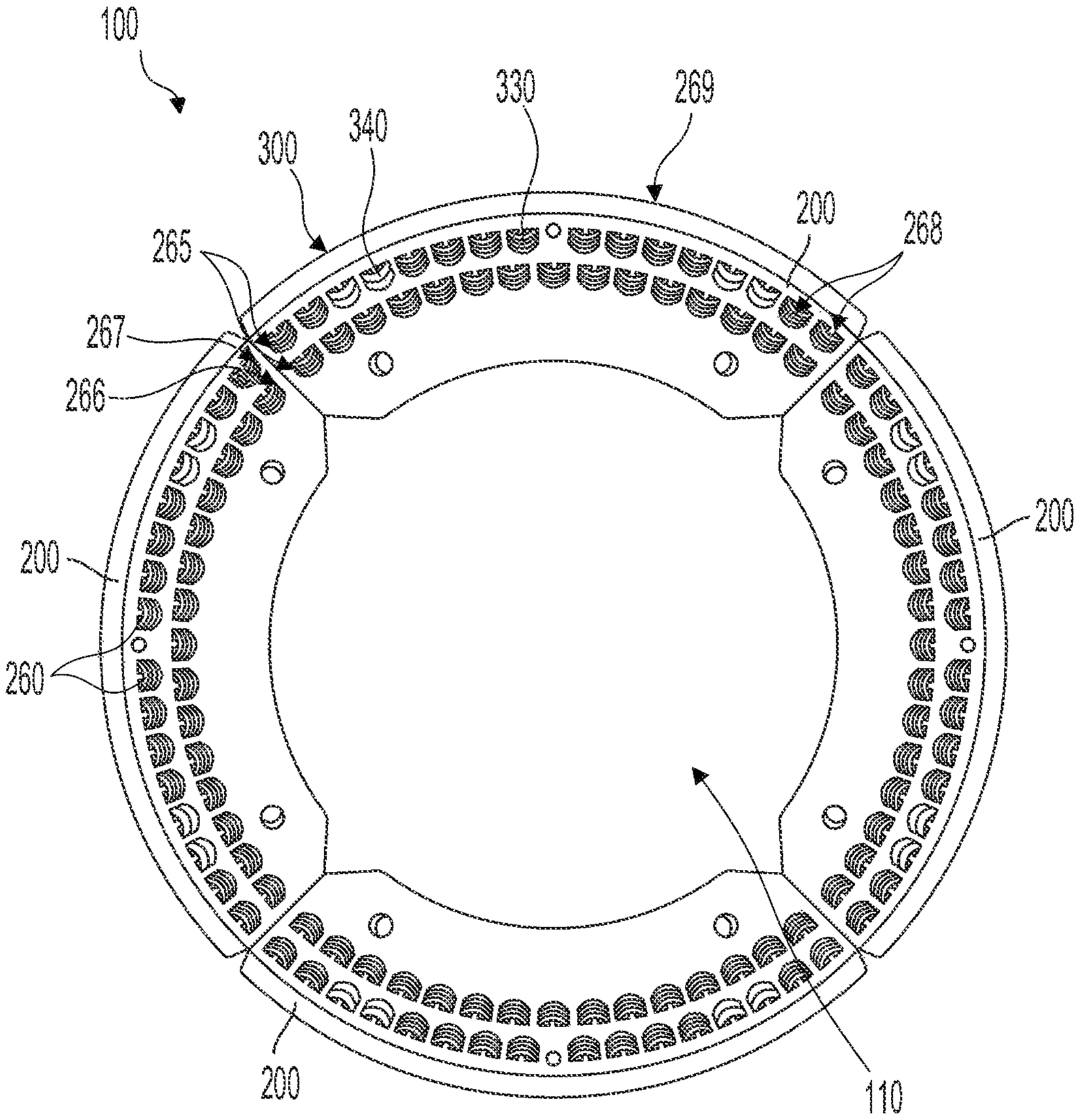

FIG. 11A

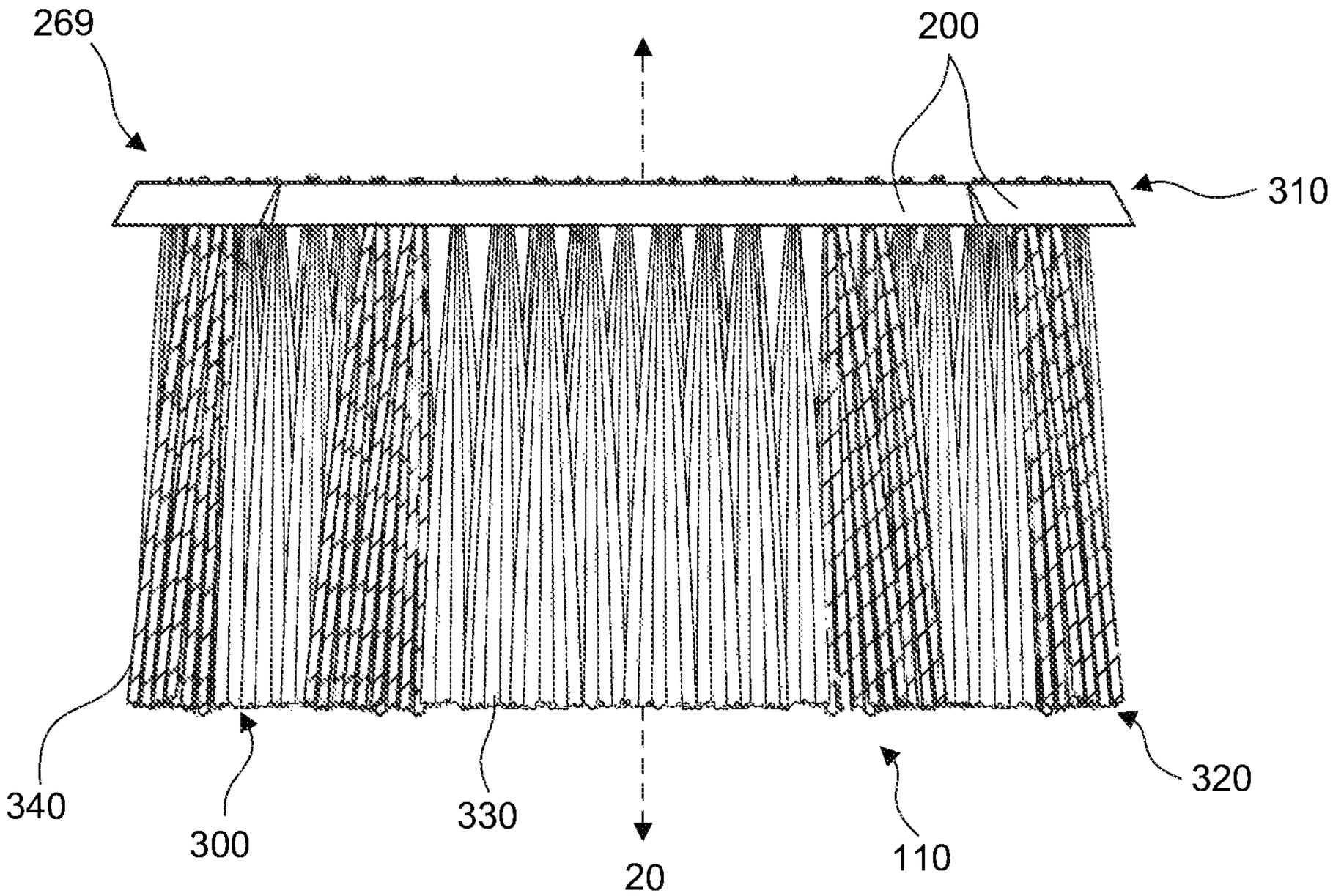

FIG. 11B

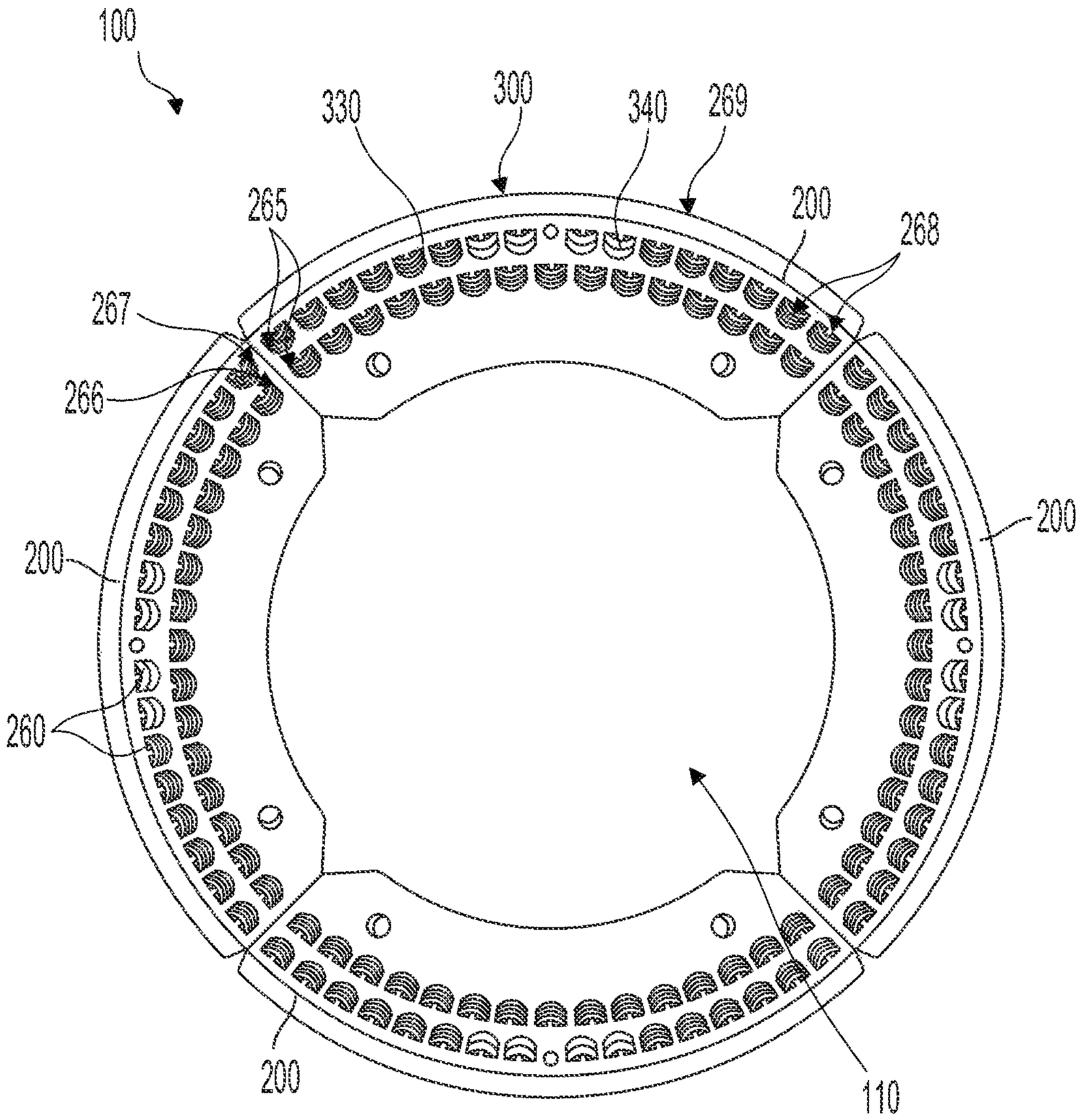

FIG. 12A

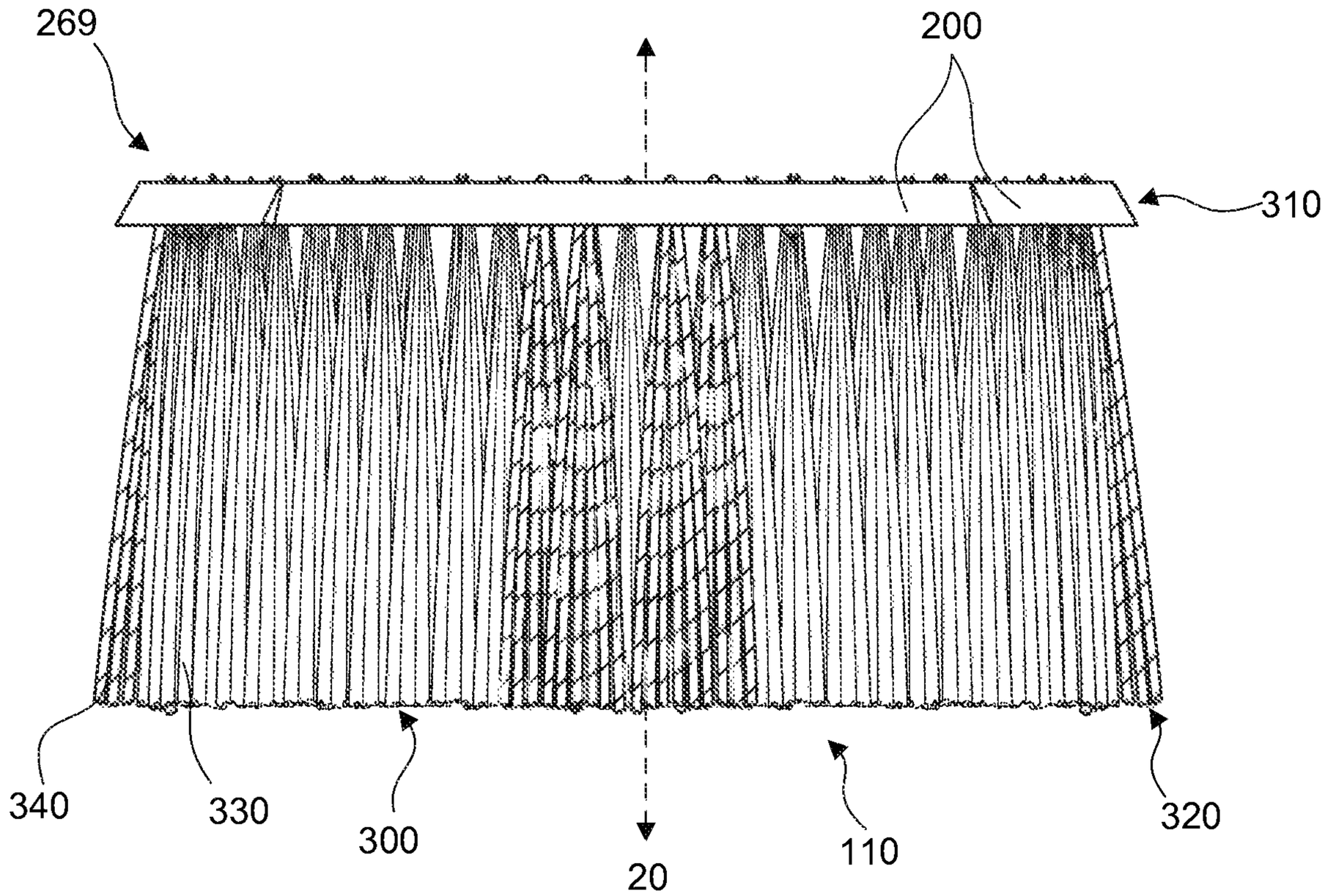

FIG. 12B

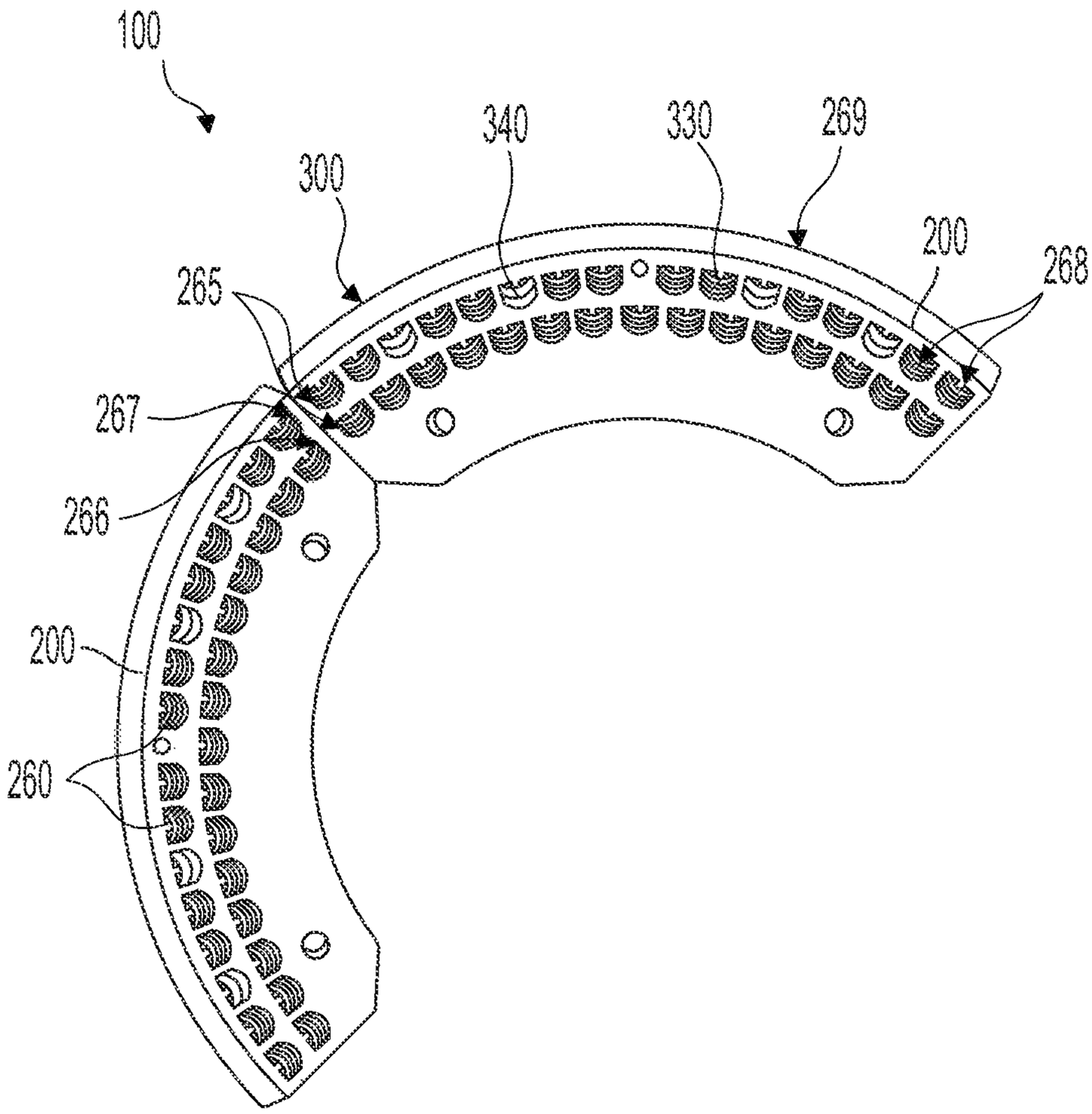

FIG. 13

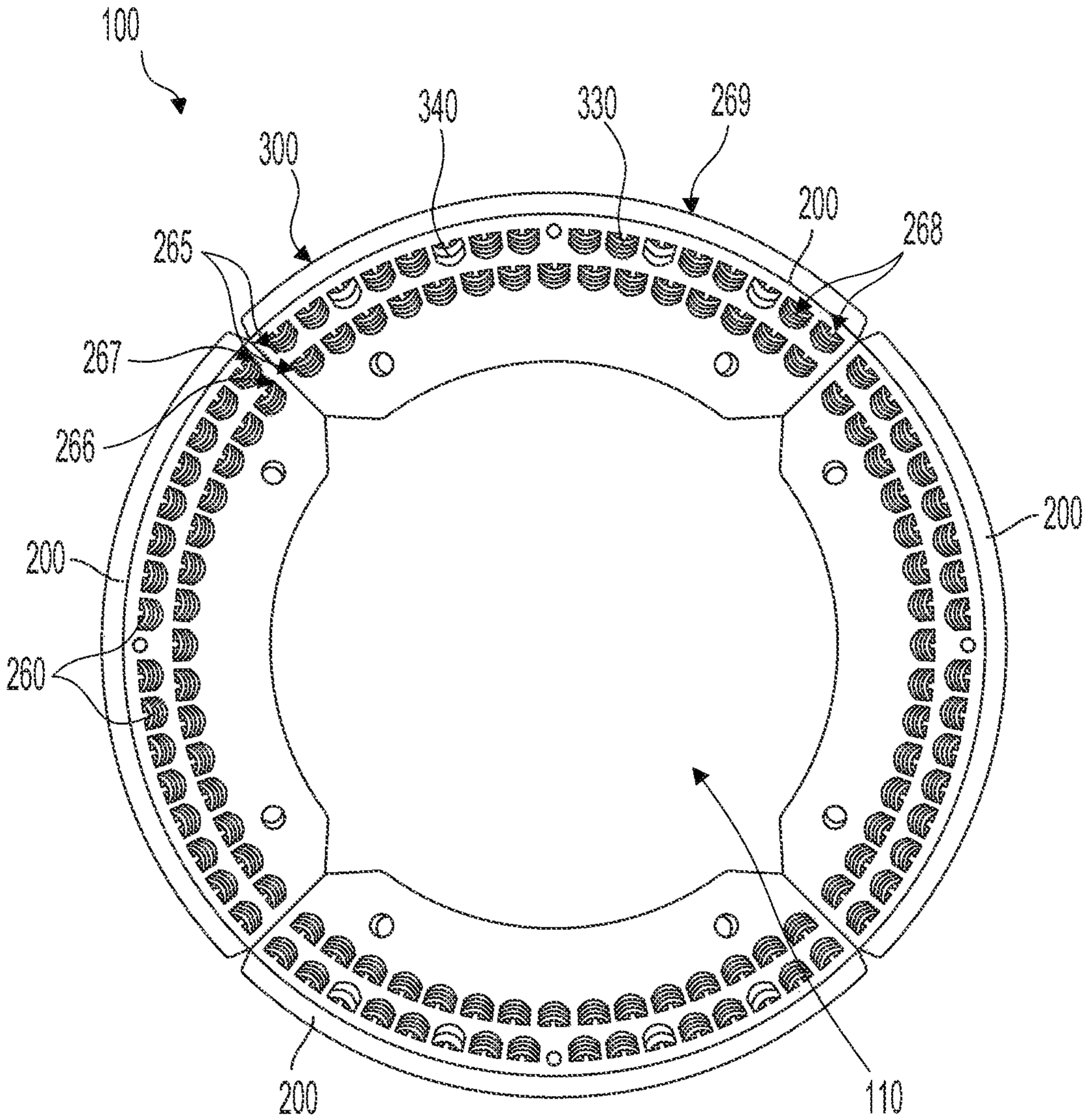

FIG. 14

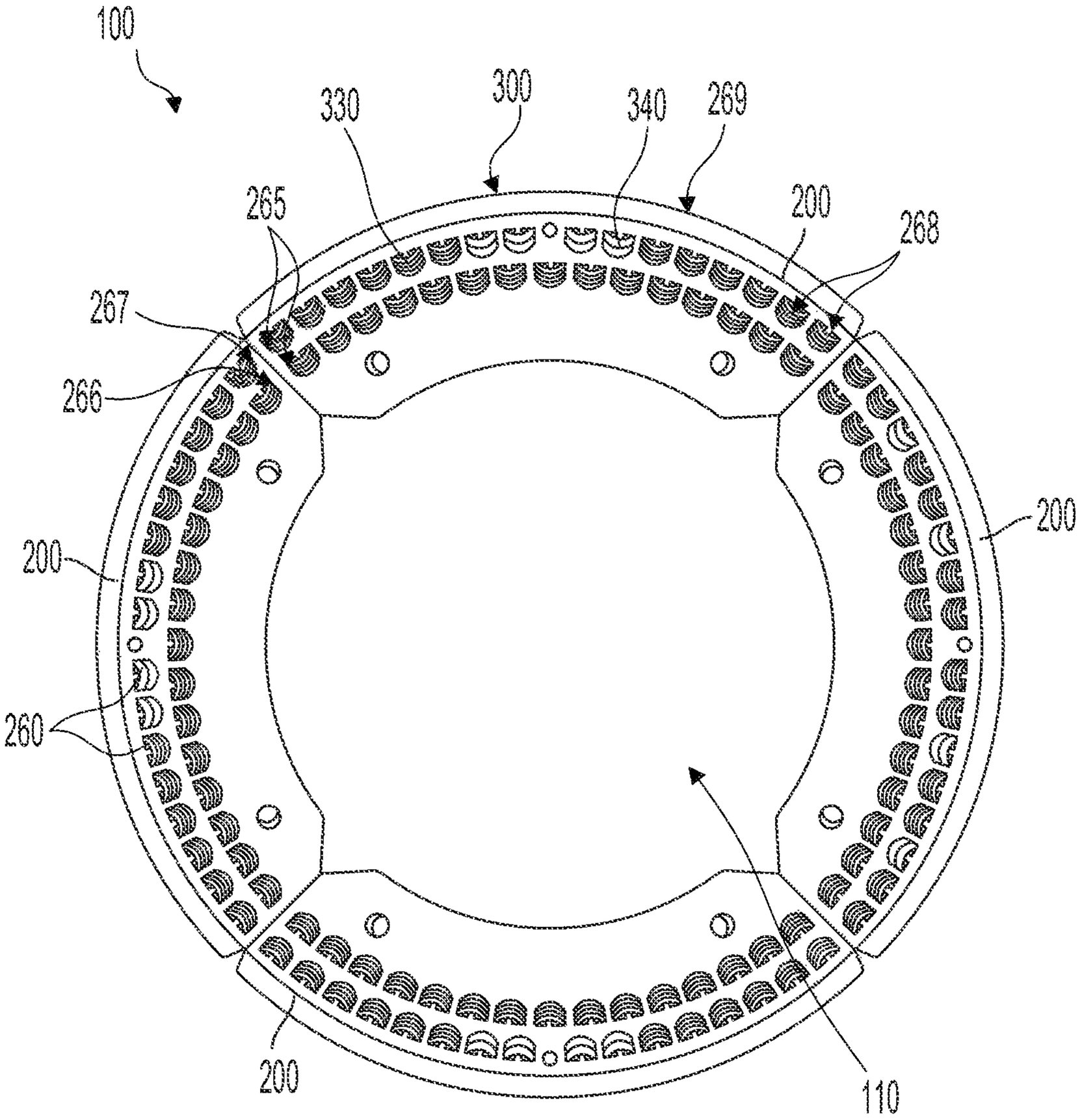

FIG. 15

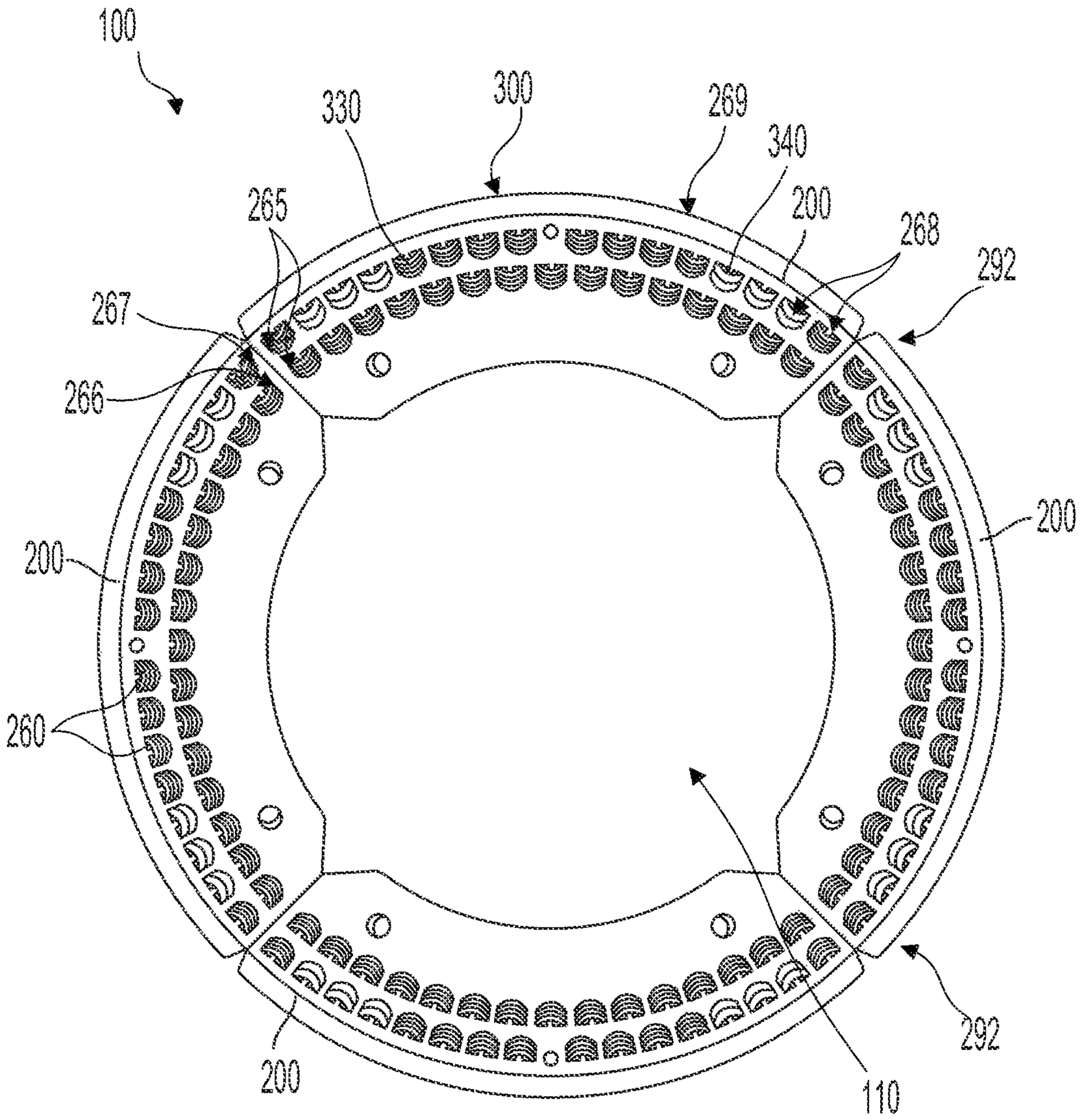
100
330
300
269
340
265
200
268
292
267
266
200
200
260
200
292
200
110

FIG. 16

CABLE BROOM

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims benefit of and priority to U.S. Provisional Patent App. No. 63/116,450, filed Nov. 20, 2020, which is incorporated herein by reference in its entirety for all purposes.

FIELD

The present disclosure relates to sweepers for cleaning surfaces. In particular, gutter brooms for cleaning roads, streets, and other surfaces.

BACKGROUND

Sweepers can be used to remove debris and particulate matter from various surfaces. In particular, a gutter broom can be used to clean roads, streets, and other surfaces and can be mounted onto a surface cleaning vehicle to move across the surface. The gutter broom can also approach a curb or a side of a building to remove debris. The gutter broom can include a brush mount that receives bristles for sweeping.

BRIEF SUMMARY

One aspect provides a block segment for a gutter broom. The block segment can include an array having rows and columns of openings to receive bristles. The bristles can include first bristles having a first stiffness and second bristles having a second stiffness greater than the first stiffness. The second bristles can be positioned alternately in openings in a given row and can be radially outward of the first bristles in a given column. The opening can extend through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment. The block segment can also include a wall extending transversely within the opening. The bristles can be positioned in the opening and surrounding the wall to form a U-shape around the wall such that a first side of the bristles and a second side of the bristles are positioned on opposite sides of the wall.

In an aspect, the second bristles can have a second cross-sectional area greater than a first cross-sectional area of the first bristles. In an aspect, the first bristles can have a first cross-sectional area of a first geometry, the second bristles have a second cross-sectional area of a second geometry. In this aspect, the first geometry and the second geometry can be different. In an aspect, the second bristles can have a second diameter greater than a first diameter of the first bristles. In an aspect, the block segment can further include a bristle receptacle attached to the block segment. In this aspect, the bristle receptacle can include the opening in which second bristles are positioned. In an aspect, the bristle receptacle can be integral to the block segment. In an aspect, the first bristles can include a first material having a first elasticity, and the second bristles can include a second material having a second elasticity. In a further aspect, the first elasticity can be greater than the second elasticity. In a further aspect, the first elasticity and the second elasticity can be approximately equal. In an aspect, the second bristles can include at least one of an outer layer, a coating, and a rib. In an aspect, the first bristles and the second bristles can include steel. In an aspect, the opening can extend through the block segment in the thickness direction from the top surface of the block segment to the bottom surface of the block segment at an angle from an axis generally parallel to a central axis of the gutter broom. The bristles can extend outwardly from the bottom surface of the block segment at the angle. In an aspect, the first bristles can be positioned generally adjacent to the second bristles.

Another aspect provides a block segment for a gutter broom. The block segment can include an array having a row and a column and bristles positioned in the array. The bristles can include first bristles having a first stiffness and second bristles having a second stiffness greater than the first stiffness. The second bristles can be positioned consecutively in the row and radially outward of the first bristles in a given column. The block segment can also include an opening arranged in the array to receive the bristles. The opening can extend through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment. The block segment can also include a wall extending transversely within the opening. The bristles can be positioned in the opening and surrounding the wall to form a U-shape around the wall such that a first side of the bristles and a second side of the bristles are positioned on opposite sides of the wall. In an aspect, the block segment can further include approximately 20 to approximately 40 openings, and approximately four to approximately eight second bristles can be positioned in the openings. In a further aspect, the approximately four to approximately eight second bristles can be positioned consecutively in the row. In an aspect, the first bristles can be positioned in the remaining openings. In a further aspect, each of the second bristles can be positioned generally adjacent to at least one first bristles. In another aspect, each of the first bristles can be generally adjacent to at least one other of the first bristles.

Another aspect provides a gutter broom. The gutter broom can include one or more block segments. Each block segment can include bristles. The bristles can include at least one of first bristles having a first stiffness and a first cross-sectional geometry and second bristles having a second stiffness different than the first stiffness and a second cross-sectional geometry different than the first cross-sectional geometry. The block segment can include an opening to receive bristles, the opening extending through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment; and a wall extending transversely within the opening, the bristles positioned in the opening and surrounding the wall to form a U-shape around the wall such that a first side of the bristles and a second side of the bristles are positioned on opposite sides of the wall. In an aspect, the gutter broom can include approximately two to approximately five block segments. In a further aspect, at least two block segments can be different.

Another aspect provides a modified block segment. The modified block segment can include a bristle receptacle to receive a bristle segment. The bristle receptacle can be internal to an outer edge of the block segment. The modified block segment can be formed during an injection mold process, for example, by placing an insert in the tooling. The insert can include a cavity to form the bristle receptacle and receive the bristle segment.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate aspects

and, together with the description, further serve to explain the principles of the aspects and to enable a person skilled in the relevant art(s) to make and use the aspects.

FIG. **1**A is a perspective view of a vehicle with a gutter broom according to various aspects.

FIG. **1**B is an enlarged view of the gutter broom in FIG. **1**A according to various aspects.

FIG. **2** is a perspective view of a gutter broom according to various aspects.

FIG. **3** is a side view of a gutter broom according to various aspects.

FIG. **4** is a top view of a block segment according to various aspects.

FIG. **5** is a cross-sectional view of the block segment in FIG. **4** along line **5**-**5** according to various aspects.

FIG. **6** is a perspective view of a block segment according to various aspects.

FIG. **7**A is a top view of a block segment according to various aspects.

FIG. **7**B is a side view of the block segment in FIG. **7**A along line **7**B-**7**B.

FIG. **8**A is a side view of a bristle according to various aspects.

FIG. **8**B is a cross-section view of the bristle in FIG. **8**A along line **8**B-**8**B.

FIG. **9**A is a side view of a bristle according to various aspects. FIG. **9**B is a cross-section view of the bristle in FIG. **9**A along line **9**B-**9**B.

FIG. **10**A is a top view of a gutter broom according to various aspects.

FIG. **10**B is a side view of the gutter broom in FIG. **10**A.

FIG. **11**A is a top view of a gutter broom according to various aspects.

FIG. **11**B is a side view of the gutter broom in FIG. **11**A.

FIG. **12**A is a top view of a gutter broom according to various aspects.

FIG. **12**B is a side view of the gutter broom in FIG. **12**A.

FIG. **13** is a top view of a gutter broom according to various aspects.

FIG. **14** is a top view of a gutter broom according to various aspects.

FIG. **15** is a top view of a gutter broom according to various aspects.

FIG. **16** is a top view of a gutter broom according to various aspects.

The features and advantages of the aspects will become more apparent from the detail description set forth below when taken in conjunction with the drawings, in which like reference characters identify corresponding elements throughout. In the drawings like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

DETAILED DESCRIPTION

The present invention(s) will now be described in detail with reference to aspects thereof as illustrated in the accompanying drawings. References to "one aspect," "an aspect," "an exemplary aspect," etc., indicate that the aspect described may include a particular feature, structure, or characteristic, but every aspect may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same aspect. Further, when a particular feature, structure, or characteristic is described in connection with an aspect, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other aspects whether or not explicitly described.

The following examples are illustrative, but not limiting, of the present aspects. Other suitable modifications and adaptations of the variety of conditions and parameters normally encountered in the field, and which would be apparent to those skilled in the art, are within the spirit and scope of the disclosure.

Aspects provide a gutter broom. As described herein, the gutter broom can be segmented and can include one or more block segments (e.g., one block segment to four or five block segments). Each block segment can have one or more openings (e.g., approximately 20 openings to approximately 40 openings) arranged in one or more rows (e.g., two rows). Each opening can receive bristles that can form a U-shape around a wall in the opening and extend downward to contact a surface to be cleaned. As the gutter broom rotates around its central axis (i.e., its axis of rotation), the bristles can clean a surface along the path of the gutter broom.

Surfaces can be made of different materials and/or amass debris, requiring varied cleaning applications. The gutter broom described herein can include patterns to adapt to a variety of surfaces. The pattern can, in part, be defined by the quantity of block segments. Each block segment can have the same or different array of openings to receive bristles for cleaning, structure of openings, and/or positioning of bristles. This, together, can form a pattern to modularly adapt a gutter broom for cleaning one or more specific surfaces.

Cleaning can target different surfaces and break down and/or remove debris. Bristles can vary in stiffness to adapt cleaning to different surfaces. For example, bristles can have a first stiffness or a second stiffness, where the second stiffness is different than the first stiffness. Bristles having the second stiffness can be stiffer to provide more aggressive cleaning than the first bristles. The quantity and/or positions of bristles having the different stiffness can be varied across gutter brooms and gutter broom blocks to further adapt cleaning. For example, on paved roads, bristles having the stiffer second stiffness can be limited to prevent damage to roads from abrasive contact, i.e., highly aggressive cleaning. In another example, bristles having the second stiffness can be positioned radially outward of bristles having the first stiffness to target surfaces having growth (e.g., weed or grass patches), such as gutter surfaces or surfaces adjacent to curbs and buildings, which are susceptible to substantial growth. Further, positioning bristles having the second stiffness in certain positions can prevent them from splaying while rotating and can thus increase their cleaning effectiveness. Bristles having different stiffness can reinforce each other and function together (e.g., as a composite) to leverage the varied stiffness and provide more efficient cleaning.

The gutter broom described herein can additionally be efficiently manufactured because each component can be discretely produced and distributed. Further, including bristles of varying stiffness can reduce the weight of the gutter broom, which can support manufacturing efficiency. Increased manufacturing efficiency can significantly reduce the cost of the gutter broom. Cost savings can additionally progress beyond manufacturing; e.g., the lower weight of the gutter broom can support extended motor life and limited operating costs. Accordingly, bristle stiffness selection and placement in the gutter broom block can be a function of surface type to both effectively clean and prevent damage from continuous abrasive contact, along with operating device motor considerations.

A gutter broom **100** is shown in FIGS. **1**A-B. In some aspects, gutter broom **100** can be mounted onto a vehicle **10** (e.g., a truck, tractor, or compact vehicle). Vehicle **10** can guide gutter broom **100** along a variety of surfaces. Gutter broom **100** can be positioned at a side of vehicle **10** to move along curbs or the sides of buildings for cleaning (e.g., sweeping, debris and/or particulate matter removal, etc.) where debris can collect. Vehicle **10** can also move gutter broom **100** along floors in, for example, manufacturing areas or retail environments. Vehicle **10** can support a driver **12** and a drive plate **50**. Driver **12** can rotate drive plate **50** and gutter broom **100** supported by drive plate **50** (e.g., via an electric or a hydraulic motor). Gutter broom **100** can rotate about its central axis **20** (i.e., its axis of rotation) to move and/or break down debris or other matter along its path (e.g., weeds, grass, mud, dirt, sand, trash, etc.). Central axis **20** can be generally perpendicular to the path along which gutter broom **100** moves (e.g., surfaces to be cleaned). In an aspect, central axis **20** can be generally vertical. Gutter broom **100** can be positioned to be generally horizontal as it rotates about the generally vertical central axis **20**. In an aspect, central axis **20** can be generally vertical. Gutter broom **100** can be positioned to be generally horizontal as it rotates about the generally vertical central axis **20**.

As shown in FIGS. **2-3** (see also FIGS. **11**A-**16**), gutter broom **100** can be segmented such that it can include one or more block segments **200**. In some aspects, gutter broom **100** can include approximately one to approximately five block segments **200**. Gutter broom **100** can also include bristles **300**. In an aspect, bristles **300** can include first bristles **330** and/or second bristles **340**. In some aspects, debris or other matter along the path of gutter broom **100** can be directed upward through an opening **110** for collection (e.g., via air suction).

Block segments **200** can be secured to drive plate **50**. In some aspects, a fixed attachment between block segments **200** and drive plate **50** can utilize bolts, adhesive, welding, etc. Block segments **200** can be secured to drive plate **50** such that they are radially arranged around central axis **20** of gutter broom **100**. Further, block segments **200** can be arced and can have a thickness, T_B.

Bristles **300** can be positioned in and can extend down from block segments **200**. Bristles **300** on gutter broom **100** can include an upper end **310** and a lower end **320**. Upper end **310** can be supported by block segments **200**, which will be described in further detail below. Lower end **320** can contact surfaces for cleaning.

In an aspect, gutter broom **100** can include first bristles **330** and/or second bristles **340**. First bristles **330** can have a first stiffness. Second bristles **340** can have a second stiffness that is different than the first stiffness. Bristles **300** having different stiffnesses can permit gutter broom **100** to be adapted for a particular surface to be cleaned. For example, the quantity and/or positions of first bristles **330** and second bristles **340** on block segment **200** can be modified to adapt cleaning by gutter broom **100**.

In an aspect, block segments **200** can be removably attached to drive plate **50**. In an aspect, bristles **300** can be removably positioned in block segments **200**. Accordingly, block segments **200** and bristles **300** can be modular such that gutter broom **100** can be adapted to a variety of surfaces after initial assembly and/or can be easily serviced. In another aspect, block segments **200** and bristles **300** can be integrally formed.

As shown in FIG. **4**, block segment **200** can include a top surface **215**, a bottom surface **225**, a first end **210**, a second end **220**, an outer edge **230**, and an inner edge **240**. Top surface **215** and bottom surface **225** can be opposing top and bottom sides of block segments **200**. First end **210** and second end **220** can be opposing transversely extending sides of block segments **200**. Outer edge **230** and inner edge **240** can be curved and can be opposing longitudinally extending sides of block segments **200**. Inner edge **240** can be radially inward of outer edge **230** such that it can face the interior of gutter broom **100**.

In some aspects, outer edge **230** can be ramped or beveled such that outer edge **230** is oblique in relation to top surface **215** and/or bottom surface **225**. The distance from central axis **20** where outer edge **230** meets bottom surface **225** can be greater than the distance from central axis where outer edge **230** meets top surface **215**. Accordingly, bottom surface **225** can extend farther from central axis **20** than top surface **215**. In some aspects, block segments **200** do not extend beyond drive plate **50**. In other aspects, outer edge **230** of a block segment **200** can extend beyond drive plate **50**. Accordingly, gutter broom **100** can be positioned to absorb lateral impact (e.g., from curbs, the sides of buildings, walls, rims, etc.).

Block segment **200** can additionally include one or more mounting alignment holes **250**. Block segment **200** can include one or more openings **260** arranged in one or more rows **265** and columns **268**. Each opening **260** can include a first sidewall **270**, a second sidewall **280**, and a wall **290**. In an aspect, openings **260** have approximately the same size and dimension, and the same wall **290**.

Openings **260** can receive and support bristles **300**, including first bristles **330** and/or second bristles **340**. As shown in FIG. **5**, openings **260** can extend through the thickness of block segments **200** from top surface **215** to bottom surface **225** (thickness, T_B, shown in FIG. **3**). Wall **290** can extend transversely through opening **260**. Bristles **300** can be U-shaped and can be inverted and inserted into openings **260**. Bristles **300** can surround wall **290** such that each side (i.e., leg of U-shape) of bristles **300** can positioned on opposite sides of wall **290**. Bristles **300** can be retained in openings **260** by fitting between first sidewall **270** and second sidewall **280**. In some aspects, bristles **300** can be retained by alternative or additional attachments, e.g., adhesive, welding, etc. In an aspect, the fitting can allow some movement of bristles **300**. In this way, bristles **300** can flex and adjust during rotation of gutter broom **100**. Bristles **300** can extend through openings **260** and outwardly from bottom surface **225** of block segment **200**. Further details on bristles **300** are provided below. In some aspects, openings **260** can be circular from a top view, however, other orientations of openings **260** are contemplated (e.g., rectangular, elliptical, etc.).

With reference to FIGS. **4-5**, in some aspects, openings **260** can be arranged in two rows **265**, a first row **266** and a second row **267**. In other aspects, openings **260** can be arranged in three or more rows **265**. In an aspect, rows **265** can be radial rows. First row **266** can be adjacent to inner edge **240**. Second row **267** can be adjacent to outer edge **230** such that it is intermediate to first row **266**. In this way, second row **267** can be the outer row and first row **266** can be the inner row. In some aspects, block segments **200** can taper from outer edge **230** to inner edge **240**. Accordingly, first row **266** can support fewer openings **260** than second row **267**. In other aspects, first row **266** can support more openings **260** than second row **267**. In some aspects, first row **266** and second row **267** can have the same number of openings **260**. In these aspects, openings **260** arranged on first row **266** can be closer together than openings **260** arranged on second row **267**.

Openings **260** in first row **266** can have a central axis **26** (i.e., an axis within the interior of opening **260**). Openings **260** in second row **267** can have a central axis **27** (i.e., an axis within the interior of opening **260**). In some aspects, openings **260** in first row **266** and openings **260** in second row **267** can be generally adjacent. In an aspect, these openings **260** can form column **268**. Accordingly, openings **260** arranged in rows **265** can also be arranged in one or more columns **268**. In an aspect, column **268** can be a radial column. In an aspect, only one opening **260** can be arranged in column **268**. In this aspect, first row **266** and second row **267** can have a different number of openings **260**. In some aspects, openings **260** can be arranged adjacently in the same row **265** at a distance, d_C. In some aspects, openings **260** can be arranged adjacently in different rows **265** at a distance, d_R. For example, d_C and/or d_R can range from approximately 1 cm to approximately 20 cm, such as 5 cm to 15 cm.

In some aspects, rows **265** and columns **268** can form an array **269**. In some aspects, array **269** and the quantity and/or positions in block segment **200** of first bristles **330** and second bristles **340** can together form one or more patterns. As discussed above, the quantity and/or positions in block segments **200** of first bristles **330** and second bristles **340** can adapt cleaning by gutter broom **100** to a variety of surfaces. Each pattern can adapt gutter broom **100** to clean one or more specific surfaces. In some aspects, openings **260** can extend through the thickness of block segments (thickness, T_B, shown in FIG. **3**) from top surface **215** to bottom surface **225** segment at one or more angles. The angle(s) at which openings **260** extend can additionally define patterns.

Openings **260** can extend through the thickness of block segments (thickness, T_B, shown in FIG. **3**) from top surface **215** to bottom surface **225** segment at an angle up to approximately 60 degrees from an axis generally parallel to central axis **20** of gutter broom **100**. As shown in FIG. **5**, in some aspects, openings **260** arranged in first row **266** can extend at an angle, α_1, from an axis **21**. For example, α_1 can range from approximately 0 degrees to approximately 60 degrees, such as approximately 10 degrees to approximately 30 degrees. Similarly, openings **260** arranged in second row **267** can extend at an angle, α_2, from an axis **22**. For example, α_2 can range from approximately 0 degrees to approximately 60 degrees, such as approximately 10 degrees to approximately 30 degrees.

In some aspects, openings **260** across first row **266** and second row **267** can extend at the same angle from axis **21** and axis **22**, respectively. Accordingly, angle, α_1, from axis **21** and angle, α_2, from axis **22** can be approximately equal. In this way, openings **260** in array **269** can be similarly angled with respect to vertical. In other aspects, openings **260** across first row **266** and second row **267** can extend at different angles from axis **21** and axis **22**, respectively. In this way, openings **260** arranged in first row **266** can extend at angle, α_1, from axis **21**, and openings **260** arranged in second row **267** can extend at angle, α_2, from an axis **22**. Alternatively, openings **260** arranged in the same row **266**/**267**, respectively, can extend at different angles from an axis generally parallel to central axis **20** of gutter broom **100**. For example, across first row **266**, one or more openings **260** can extend at an angle, α_1, from axis **21**. Similarly, across second row **267**, one or more openings **260** can extend at an angle, α_2, from an axis **22**.

With reference to FIGS. **5-6**, bristles **300** can extend through openings **260** and outward from bottom surface **225** of block segment **200**. Across first row **266**, bristles **300** can extend outward from bottom surface **225** of block segments **200** substantially along central axis **26** at an angle, α_1, from an axis **21**. Across second row **267**, bristles **300** can extend outward from bottom surface **225** of block segments **200** substantially along central axis **27** at an angle, α_2, from an axis **22**. In some aspects, bristles **300** extending at angle, α_1, from axis **21** or angle, α_2, from axis **22** can be offset from and/or generally parallel to adjacent bristles **300** (e.g., in the same row **265** or different row **265**). Offsetting bristles **300** can lessen contact between generally adjacent bristles **300** as gutter broom **100** rotates around central axis **20**. In an aspect, this can allow for longer bristles **300**. In some aspects, first bristles **330** having a first stiffness and second bristles **340** having a second stiffness can be positioned in openings **260** according to angle, α_1, from axis **21** and angle, α_2, from axis **22**. In this way, the angle(s) at which first bristles **330** and second bristles **340** extend can additionally define patterns to adapt gutter broom **100** to clean one or more specific surfaces.

As shown in FIGS. **6-7**B, in some aspects, a block segment **2000** can be similar to block segment **200** and can include and/or support similar components as block segment **200**. In an aspect, block segment **2000** can additionally include a bristle receptacle **2950**.

In an aspect, bristle receptacle **2950** can be integrally formed with block segment **2000**. In another aspect, bristle receptacle **2950** can be attached to block segment **2000** utilizing bolts, adhesive, welding, etc. In an additional aspect, bristle receptacle **2950** can be removable such that it is modular and placement of it on block segment **2000** can be selected. In an aspect, bristle receptacle **2950** can be injection molded with block segment **2000**. In some aspects, bristle receptacle **2950** can support bristles **3000**. Bristles **3000** can be positioned in and can extend down from bristle receptacle **2950**. Bristles **300** can be retained in bristle receptacle **2950** via a snap fit, press fit, or another attachment method (e.g., adhesive, bolts, welding, etc.). In an aspect, second bristles **3400** can be positioned in a cavity of bristle receptacle **2950**. In another aspect, first bristles **3300** and/or second bristles **3400** can be positioned in bristle receptacle **2950**. In some aspects, bristles **3000** retained by bristle receptacle **2950** can be angled similar to bristles **300** retained by block segment **2000**. The addition and/or placement of bristle receptacle **2950** can additionally form patterns on the block segment **2000** to adapt cleaning for a particular application.

In another aspect, block segment **2000** can be modified to include bristle receptacle **2950** internal to outer edge **2300**. In this aspect, bristle receptacle **2950** can be formed during an injection mold process, for example, by placing an insert in the tooling. The insert can include a cavity to form bristle receptacle **2950**, which can receive the bristles.

With reference to FIGS. **5-7**B, in some aspects, respective openings **260**/**2600**, first sidewall **270**/**2700**, second sidewall **280**/**2800**, and/or wall **290**/**2900** can be dimensioned differently and/or be reinforced to retain second bristles **340**/**3400**. The increased size and/or strength can be sufficient to resist additional forces generated by the stiffer second bristles **340**/**3400**.

With reference to FIGS. **8**A-**9**B, bristles **300** can comprise one or more of metals, plastics, composites, ceramics, polymers, natural fibers, etc. For example, bristles **300** can comprise one or more of steel, aluminum, nylon, polyester, polypropylene, PVC, vegetable fibers, or hairs. In an aspect, bristles **300** can comprise flattened steel wire. In an aspect, bristles **300** placed within an opening **260** can include, for example, approximately fifteen to approximately thirty individual bristles. Other aspects provide that bristles **300** can be

composed of other materials, or a blend of materials. For example, bristles **300** can have a steel and polypropylene mix. In another aspect, bristles **300** can comprise polyurethane or other composite material that is approximately 0.1 cm to approximately 0.21 cm in diameter. In some aspects, bristles **300** can be round and straight or crimped.

Including bristles **300** of different materials with different structural properties on a single block segment **200** can improve cleaning capability for a specific type of debris or surface. In another aspect, bristles **300** can vary in length, which can improve cleaning capability for a specific type of debris or surface, for example, an intermediate surface. In this aspect, the types of bristles **300** in a block segment **200** can be customized to improve cleaning capability for a specific type of debris or surface. Accordingly, material and profiles of bristles **300** can additionally define patterns to adapt gutter broom **100** to clean one or more specific surfaces. For example, gutter brooms generally can be used outdoors to clean streets that require different types or levels of contact (e.g., abrasive or fine). Streets can vary in granularity and can be made from various materials, e.g., concrete, brick, cobblestone, and/or asphalt, each requiring different cleaning methods. Streets can also include growth, such as patches of grass or weeds. In another example, streets can have other natural debris, such as sand, mud, and rocks, or non-natural debris, such as trash and recyclables. Accordingly, cleaning by gutter broom **100** can be enhanced to effectively clean these distinct surfaces, growth, and/or debris by modifying the bristles **300** and/or pattern of bristles **300** in block segment **200**.

In an aspect, gutter broom **100** can include bristles **300** that can be first bristles **330** having a first stiffness and/or second bristles **340** having a second stiffness. First bristles **330** and second bristles **340** can be selectively placed on block segment **200** to define patterns to adapt gutter broom **100** to clean one or more specific surfaces. For example, second bristles **340** having a second stiffness greater than the first stiffness of first bristles **330** can provide a more abrasive contact on the surface being cleaned to better target debris, such as growth and compacted mud along streets. First bristles **330** having a first stiffness less than the second stiffness of second bristles **340** can provide a finer contact, for example, to remove sand and dust. Gutter broom **100** can include first bristles **330** and/or second bristles **340** to provide both abrasive and fine contact with surfaces.

In some aspects, first bristles **330** and second bristles **340** can be positioned in the same opening **260** in block segment **200**. In an aspect, the stiffness of one or more portions of gutter broom **100** can be modified by increasing or decreasing the number of first bristles **330** or second bristles **340** in each opening **260**.

In other aspects, respective openings **260** can include first bristles **330** or second bristles **340**. In this aspect, the stiffness of one or more portions of gutter broom **100** can be modified by specifically positioning first bristles **330** and second bristles **340** in particular openings **260** on block segment **200**. In an aspect, second bristles **340** can be positioned in openings **260** arranged in first row **266** and/or second row **267**. In another aspect, second bristles **340** can be positioned in openings **260** only arranged in second row **267**. Gutter broom **100** can also be customized by including fewer bristles **300**. For example, bristles **300** can be omitted in openings **260** to create a paddle-type contact with surfaces, e.g., to clean around snow.

The position of first bristles **330** and second bristles **340** can be defined and/or modified based on the desired surface to be cleaned. For example, growth on surfaces can occur along curbs or the sides of building. Accordingly, stiffer bristles to target this debris, e.g., second bristles **340** having a second stiffness greater than the first stiffness of first bristles **330**, can be positioned across second row **267**.

Furthermore, the positions of first bristles **330** and/or second bristles **340** can additionally define patterns to adapt gutter broom **100** for a particular cleaning application. In an aspect, gutter broom **100** can include more first bristles **330** than second bristles **340** to limit abrasive contact and prevent damage to surfaces. In this way, the quantity of first bristles **330** and/or second bristles **340** can additionally define patterns.

First bristles **330** can have a first stiffness less than the second stiffness of second bristles **340**. Stiffness can be determined by material, diameter, cross-sectional area, cross-section geometry, wall thickness, outer layers, coatings for reinforcement, ribbing, openings, etc. For example, first bristles **330** can have a cross-sectional geometry that is circular, elliptical, rectangular, or a star, plus sign, etc. As shown in FIGS. **8**A-B, first bristles **330** can be made of steel, e.g., flattened spring steel. In other aspects, first bristles **330** can comprise other materials (e.g., metals, plastics, composites, ceramics, polymers, natural fibers, etc.). In an aspect, first bristles **330** can include material having a first modulus of elasticity that is less than a second modulus of elasticity of material of second bristles **340**.

In other aspects, first bristles **330** and second bristles **340** can be the same material, but can have variable stiffness based on other properties such as diameter, cross-sectional area, cross-section geometry, wall thickness, outer layers, coatings for reinforcement, ribbing, openings, etc. In some aspects, the diameter of each first bristle **330** can be approximately 0.5 mm. In another aspect, the diameter of each first bristle **330** can be approximately 0.2 cm to approximately 0.4 cm wide, and approximately 0.05 cm to approximately 0.11 cm hardened spring steel. In another aspect, first bristles **330** can be compacted cable between approximately 0.3 cm and approximately 1.2 cm in diameter. In another aspect, first bristles **330** are flattened drawn wire having a rectangular cross section. The thickness can range from approximately 0.076 cm (0.03 in) to approximately 0.127 cm (0.05 in). The width can range from approximately 0.2 cm (0.08 in) to approximately 0.5 cm (0.2 in). In an aspect, first bristles **330** can have a first cross-section that has a first geometry. In an aspect, properties of first bristles **330** can have a lower moment of inertia with respect to the surface plane. Accordingly, first bristles **330** can be useful for finer cleaning to target separations between various surfaces. Greater movement and flexibility can be realized at impact such that first bristles **330** can buckle to reach crevices, granularity, gaps, etc. Additionally, first bristles **330** can better target lighter debris (e.g., sand and dust) and particulate matter.

As shown in FIGS. **9**A-B, second bristles **340** can be made of steel, e.g., flattened spring steel. In other aspects, second bristles **340** can comprise other materials (e.g., metals, plastics, composites, ceramics, polymers, natural fibers, etc.). In an aspect, each second bristle **340** can have a diameter in a range from approximately 0.3 cm (0.125 in) to approximately 0.8 cm (5.16 in). In an aspect, second bristles **340** can be hardened spring steel and can have a diameter in a range from approximately 0.05 cm to approximately 0.11 cm. In another aspect, second bristle **340** can be compacted cable between and can have a diameter in a range from approximately 0.3 cm to approximately 1.2 cm. In some aspects, the diameter of each second bristle **340** can be approximately 0.476 cm (approximately 3⁄16 in). Second

bristles **340** can be thicker than first bristles **330** such that second bristles **340** are stiffer. In other aspects, second bristles **340** can be folded over a composite "core" (i.e., a center mass) such that they are stiffer than first bristles **330**.

In some aspects second bristles **340** can be a rod or flat shape comprising poly material. In some aspects, second bristles **340** can be coated in poly material. In these aspects, based on testing, gutter broom **100** enhances cleaning of growth (e.g., vegetation and/or dirt/mud cleaning). In these aspects, each second bristle **340** can have a diameter in a range from approximately 0.1 cm to approximately 3 cm, such as approximately 0.3 cm (0.125 in) to approximately 1.27 cm (0.5 in) or 1.9 cm (0.75 in).

In an aspect, second bristles **340** can have a second cross-section that has a second geometry. In some aspects, second bristles **340** can have a cross-sectional geometry that is circular, elliptical, rectangular, or a star, plus sign, etc. The cross-sectional geometry can provide the increased stiffness of second bristles **340**. For example, in some aspects, second bristles **340** can have a ribbed exterior. Force from lateral impact can be transferred to openings between ribs. In this way, second bristles **340** can absorb impact and reduce flexing (i.e., second bristles **340** can be stiffer). In an aspect, second bristles **340** can have a higher moment of inertia with respect to the surface plane. Accordingly, the relatively stiffer second bristles **340** can be useful for more aggressive cleaning to target debris that can be tougher to move and/or break down (i.e., cut), such as growth, compacted mud, rocks, etc. The higher stiffness can reduce buckling and provide an inertial impact to move tougher debris. Second bristles **340** that are arranged together (e.g., grouped or adjacently) can grip and/or break down tougher debris more effectively.

As discussed above, bristles **300** can extend from block segments **200** at an angle from an axis generally parallel to central axis **20** of gutter broom **100**. Angles, positions, stiffness, material, diameter, length, cross-section geometry, and combinations thereof of bristles **300** can create patterns to adapt gutter broom **100** to a variety of surfaces for cleaning. For example, gutter surfaces, which can be difficult to clean (e.g., because debris can be compacted from irregular cleaning and/or because the surface itself is difficult to reach), can be effectively cleaned by second bristles **340**, which can be stiffer. Accordingly, in some aspects, second bristles **340** can be positioned radially outward of first bristles **330** to reach gutter surfaces. Angling second bristles **340** can further assist gutter broom **100** in targeting this debris. In other aspects, second bristles **340** can additionally or alternatively be positioned radially inward of first bristles **330** to target debris on the ground surface.

With reference to FIGS. **10**A-**15**, as discussed above, gutter broom **100** can be segmented such that it can include one or more block segments **200**. In some aspects, each block segment can have the same or different arrays **269**, structure of openings **260**, and/or positioning of bristles **300**, including positioning of first bristles **330** and/or second bristles **340**. This can additionally define patterns to adapt gutter broom **100** to a variety of surfaces for cleaning. Different gutter broom **100** patterns will now be described in detail.

As shown in FIGS. **10**A-B, in some aspects, each block segment **200** of gutter broom **100** can include openings **260** arranged in first row **266** and second row **267**. In some aspects, block segment **200** can have approximately 31 openings **260**. As discussed above, in some aspects, first row **266** can have more openings **260** than second row **267**. Accordingly, first row **266** can have approximately 16 openings **260** and second row **267** can have approximately 15 openings **260**. Each opening **260** in each first row **266** can receive and support bristles **300**. In some aspects, both first bristles **330** having a first stiffness and second bristles **340** having a second stiffness greater than the first stiffness can be positioned in openings **260**. In an aspect, second bristles **340** can be positioned in a number of openings **260** arranged in second row **267**. In an aspect, approximately four second bristles **340** can be positioned in openings **260** arranged in second row **267**. Accordingly, first bristles **330** can be positioned in the remaining openings **260** in second row **267** and/or first row **266**. In this way, second bristles **340** can be radially outward of first bristles **330** in columns **268**.

In an aspect, four of the openings **260** in second row **267** can include second bristles **340**. In an aspect, the second bristles **340** can be alternately positioned in openings **260** in second row **267** such that they are only adjacent to first bristles **330** in second row **267**. In an aspect, first bristles **330** and second bristles **340** positioned adjacently can move together as gutter broom **100** rotates around central axis **20**. Adjacent first bristles **330** and second bristles **340** can reinforce each other and prevent splaying by distributing radial support. In this way, first bristles **330** and second bristles **340** can be retained in their general positions. In a further aspect, second bristles **340** can be positioned in openings **260** in second row **267** such that at least two openings **260** containing first bristles **330** are positioned between each opening **260** containing second bristles **340**. In another aspect, each of the openings **260** in the first row **266** can contain first bristles **330**. In a separate aspect, one or more of the openings **260** in the first row **266** can contain second bristles **340**.

With reference to FIGS. **11**A-B, in an aspect, four of the openings **260** in second row **267** can include second bristles **340**. In an aspect, two consecutive openings **260** in second row **267** can include second bristles **340**. Openings **260** positioned adjacent to the two consecutive openings **260** can include first bristles **330**. In an aspect, second bristles **340** can be alternately and consecutively positioned in second row **267** such that each second opening **260** containing second bristles **340** is adjacent to only one other second bristles **340**. Including two consecutive openings **260** in second row **267** with second bristles **340** can allow second bristles **340** to support each other to produce a more abrasive contact onto the cleaning surface. In another aspect, each of the openings **260** in the first row **266** can contain first bristles **330**. In a separate aspect, one or more of the openings **260** in the first row **266** can contain second bristles **340**.

With reference to FIGS. **12**A-B, in an aspect, four of the openings **260** in second row **267** can include second bristles **340**. In an aspect, four or more openings **260** including second bristles **340** can be consecutively positioned in second row **267** such that all openings **260** containing second bristles **340** are adjacent to each other. In this way, adjacent second bristles **340** having a greater second stiffness can strengthen each other to produce a more abrasive contact. Additionally, adjacent first bristles **330** across, e.g., first row **266**, can reinforce second bristles **340** and prevent splaying by distributing radial support. In another aspect, each of the openings **260** in the first row **266** can contain first bristles **330**. In a separate aspect, one or more of the openings **260** in the first row **266** can contain second bristles **340**.

With reference to FIG. **13**, in an aspect, gutter broom **100** can include multiple block segments **200**. In some aspects, the multiple block segments **200** can have the same pattern of first bristles **330** and second bristles **340** in openings **260**.

In other aspects, gutter broom **100** can include multiple block segments **200** having different patterns of first bristles **330** and second bristles **340**, e.g., any of the patterns in FIG. **10**A, **11**A, or **12**A. Varying patterns of block segments **200** can vary contact with debris and surfaces as needed during the life of gutter broom **100**.

With reference to FIGS. **14-15**, in an aspect, approximately one or more block segments **200** can have the same pattern of first bristles **330** and second bristles **340**, and other block segments **200** can have a different pattern of first bristles **330** and second bristles **340**. The other block segments **200** can have the same or different patterns of first bristles **330** and second bristles **340**.

As shown in FIG. **14**, gutter broom **100** can include first and second block segments **200** having openings **260** containing only first bristles **330**, and third and fourth block segments **200** having openings **260** containing first bristles **330** and second bristles **340** according to the pattern shown in FIG. **10**A.

As shown in FIG. **15**, gutter broom **100** can include two or more block segments **200** having openings **260** containing first bristles **330** and second bristles **340** according to a same pattern, such as any of the patterns shown in FIG. **10**A, **11**A, or **12**A, and another block segment **200** containing another a different pattern, such as another of the patterns shown in FIG. **10**A, **11**A, or **12**A. In an aspect, gutter broom **100** can include two or more block segments **200** according to the pattern shown in FIG. **12**A and another block segment **200** according to the pattern shown in FIG. **10**A.

As shown in FIG. **16**, gutter broom **100** can include one or more block segments **200** having openings **260** containing first bristles **330** and second bristles **340** according to a same pattern (e.g., approximately four to approximately five block segments **200**). In this aspect, each block segment **200** can include two or more openings **260** (e.g., three openings) including second bristles **340** consecutively positioned in second row **267** such that all openings **260** containing second bristles **340** are adjacent to each other. In some aspects, the two or more openings **260** including second bristles **340** can be consecutively positioned in second row **267** such that they are collectively adjacent to one opening **260** including first bristles **330** on an outer end **292** of a block segment **200**. In some aspects, each of the one or more block segments **200** can have multiple groupings of two or more openings **260** including second bristles **340** consecutively positioned in second row **267**. In this aspect, each of the groupings of three or more openings **260** including second bristles **340** consecutively positioned in second row **267** can be collectively adjacent to one opening **260** including first bristles **330** on outer end **292** of a block segment **200**. Accordingly, second row **267** can include one or more groupings of second bristles **340** consecutively positioned in second row **267**. In some aspects, where block segment **200** can have approximately 31 openings **260** and each block segment **200** has two groupings of three openings **260** including second bristles **340** consecutively positioned in second row **267**, each grouping can be separated by at least six openings **260** (e.g., eight openings **260**) including second bristles **330**.

In some aspects, block segment **200** can include 0.635 cm (0.25 in) super swaged cables. In some aspects, second bristles **340** can include approximately 15 super swaged cables to approximately 40 super swaged cables, such as approximately 24 super swaged cables. In some aspects, any of the patterns contemplated can include second bristles **340** having a length of approximately 50 mm to approximately 90 mm, such as approximately 65 mm to approximately 85 mm, such as approximately 65 mm to approximately 80 mm, such as approximately 66 mm (e.g., 26 in). In some aspects, second bristles **340** can be approximately 2 cm to approximately 3 cm longer than first bristles **330**, such as approximately 2.54 cm (e.g., 1 in). In some aspects, second bristles **340** longer than first bristles **330** can improve performance in terms of cleaning efficiency at the beginning of life. For example, second bristles **340** can scrape a surface better (e.g., harder) while first bristles **330** remain less stiff and more flexible.

Based on testing, gutter broom **100**, e.g., gutter broom **100** provided in FIG. **16**, enhances cleaning of growth (e.g., vegetation and/or dirt/mud cleaning). Gutter broom **100** can also efficiently clean an area in one pass, 90% of the time. In contrast, conventional gutter brooms **100** require at least three passes to efficiently clean an area. Additionally, gutter broom **100** have a lifetime of at least 2-2.5 longer than the conventional gutter broom. For example, conventional gutter brooms have a lifetime of approximately 30-40 hours before replacement is required. This may be because conventional gutter brooms require multiple passes over difficult areas, e.g., areas with growth for cleaning. Gutter broom **100** includes a 2-2.5 longer lifetime (e.g., 60-80 hours before replacement is required) and additionally includes modular components that can be serviced and/or replaced as needed. The substantial increase in lifetime is, in part, because cleaning of difficult areas with growth is more efficient in the first pass. Testing between gutter broom **100** and conventional gutter brooms included comparing a constant load and RPM on a constant surface, e.g., concrete construction cinder blocks.

In some aspects, second bristles **340** can include swaged cable with poly coating. In some aspects, based on testing, unraveled cable comprising second bristles **340** perform better than conventional gutter broom inserts with respect to cleaning efficiency in areas comprising growing (g., vegetation and/or dirt/mud cleaning). In these aspects, based on testing, broom segment **200** can remain intact and undamaged.

It is to be appreciated that the Detailed Description section, and not the Summary and Abstract sections, is intended to be used to interpret the claims. The Summary and Abstract sections may set forth one or more but not all exemplary aspects of the present invention as contemplated by the inventor(s), and thus, are not intended to limit the present invention and the appended claims in any way.

The present invention has been described above with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed.

The foregoing description of the specific aspects will so fully reveal the general nature of the invention that others can, by applying knowledge within the skill of the art, readily modify and/or adapt for various applications such specific aspects, without undue experimentation, without departing from the general concept of the present invention. Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed aspects, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the

present specification is to be interpreted by the skilled artisan in light of the teachings and guidance.

The breadth and scope of the present invention should not be limited by any of the above-described exemplary aspects, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A block segment for a gutter broom, comprising:

openings to receive bristles, the openings extending through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment, the openings arranged in an outer row and an inner row positioned radially inward of the outer row;

bristles positioned in the openings and comprising first bristles having a first stiffness and second bristles having a second stiffness greater than the first stiffness, the second bristles being positioned only in the outer row, the first bristles being positioned in the inner row and in the outer row adjacent the second bristles; and

a wall extending transversely within each opening, the respective bristles positioned in the opening surrounding the wall to form a U-shape such that a first side of the bristles and a second side of the bristles are positioned on opposite sides of the wall.

2. The block segment of claim **1**, wherein the second bristles have a second cross-sectional area greater than a first cross-sectional area of the first bristles.

3. The block segment of claim **1**, wherein the first bristles have a first cross-sectional area of a first geometry, and

wherein the second bristles have a second cross-sectional area of a second geometry different from the first geometry.

4. The block segment of claim **1**, wherein the second bristles have a second diameter greater than a first diameter of the first bristles.

5. The block segment of claim **1**, wherein the first bristles comprise a first material having a first modulus of elasticity, and

wherein the second bristles comprise a second material having a second modulus of elasticity greater than the second modulus of elasticity.

6. The block segment of claim **1**, wherein the first bristles comprise a first material having a first modulus of elasticity, and

wherein the second bristles comprise a second material having a second modulus of elasticity approximately equal to the first modulus of elasticity.

7. The block segment of claim **1**, wherein the second bristles comprise at least one of an outer layer, a coating, and ribbing.

8. The block segment of claim **1**, wherein the first bristles and the second bristles comprise a metal.

9. The block segment of claim **1**, wherein one of the openings extends through the block segment in the thickness direction from the top surface of the block segment to the bottom surface of the block segment at an angle from an axis generally parallel to a central axis of the gutter broom, and

wherein the bristles extend outwardly from the bottom surface of the block segment at the angle.

10. The block segment of claim **1**, wherein the first bristles are positioned generally adjacent to the second bristles.

11. A block segment for a gutter broom, comprising:

a plurality of bristle openings, the plurality of bristle openings being arranged in a plurality of rows, the plurality of rows comprising an outer row and an inner row radially inward of the outer row, and the bristle openings extending through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment; and

bristles comprising first bristles having a first stiffness and second bristles having a second stiffness greater than the first stiffness, the outer row comprising the first bristles adjacent the second bristles and the inner row comprising the first bristles such that at least one inner row opening containing the first bristles is radially adjacent at least one outer row opening containing the second bristles the second bristles being positioned in the outer row, and the first bristles positioned adjacent the second bristles in the outer row and radially inward of the second bristles in the inner row.

12. The block segment of claim **11**, further comprising approximately 20 to approximately 40 bristle openings, wherein second bristles are positioned in approximately four to approximately eight of the bristle openings.

13. The block segment of claim **12**, wherein at least two of the bristle openings containing the second bristles are adjacent in the outer row.

14. The block segment of claim **12**, wherein the first bristles are positioned in the remaining bristle openings.

15. The block segment of claim **14**, wherein each of the second bristles is positioned generally adjacent to at least one of the first bristles.

16. The block segment of claim **14**, wherein each of the first bristles is positioned generally adjacent to at least one other of the first bristles in the inner row.

17. A gutter broom, comprising:

one or more block segments, each block segment comprising:

bristles comprising at least one of first bristles having a first stiffness and a first cross-sectional geometry and second bristles having a second stiffness different than the first stiffness and a second cross-sectional geometry different than the first cross-sectional geometry;

an opening to receive the bristles, the opening extending through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment; and

a wall extending transversely within the opening, the bristles positioned in the opening and surrounding the wall to form a U-shape around the wall such that a first side of the bristles and a second side of the bristles are positioned on opposite sides of the wall.

18. The gutter broom of claim **17**, wherein the gutter broom comprises approximately two to approximately five block segments.

19. The gutter broom of claim **18**, wherein at least two block segments are different such that each block segment comprises a different pattern of the first bristles and the second bristles.

20. The gutter broom of claim **17**, wherein the first bristles comprising a greater number of individual bristles than the second bristles.

21. A block segment for a gutter broom, comprising:

an outer row of openings to receive bristles, the openings extending through the block segment in a thickness direction from a top surface of the block segment to a bottom surface of the block segment;

an inner row of openings to receive bristles, the openings extending through the block segment in the thickness direction from the top surface of the block segment to the bottom surface of the block segment;

first bristles having a first stiffness, the inner row of openings comprising first bristles; and

second bristles having a second stiffness greater than the first stiffness, the outer row comprising first bristles and second bristles such that a first outer row opening comprises first bristles, a second outer row opening adjacent to the first outer row opening comprises first bristles, a third outer row opening adjacent to the second outer row opening comprises at least one second bristle, and a fourth outer row opening adjacent to the third outer row opening comprises at least one second bristle.

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